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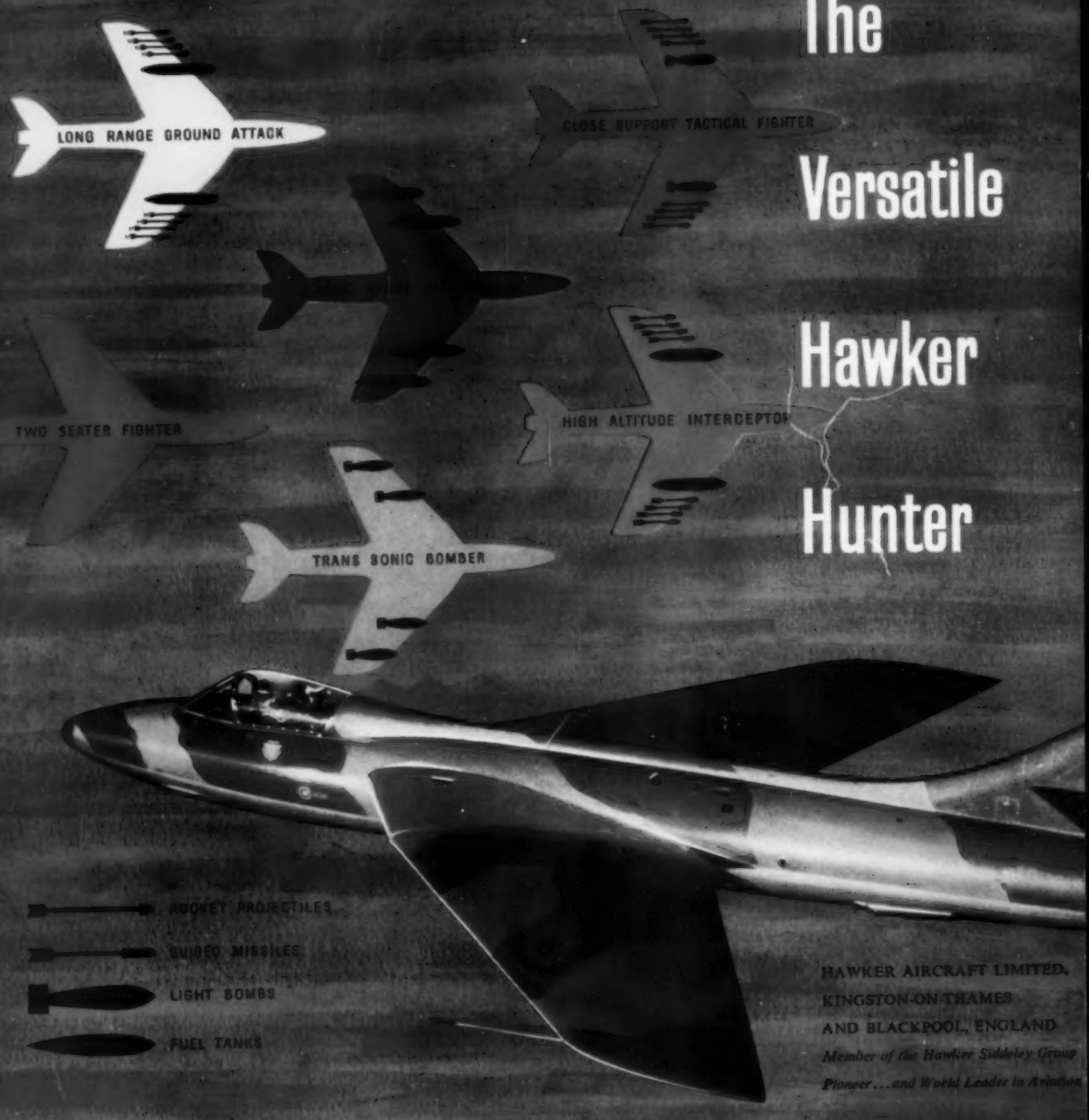

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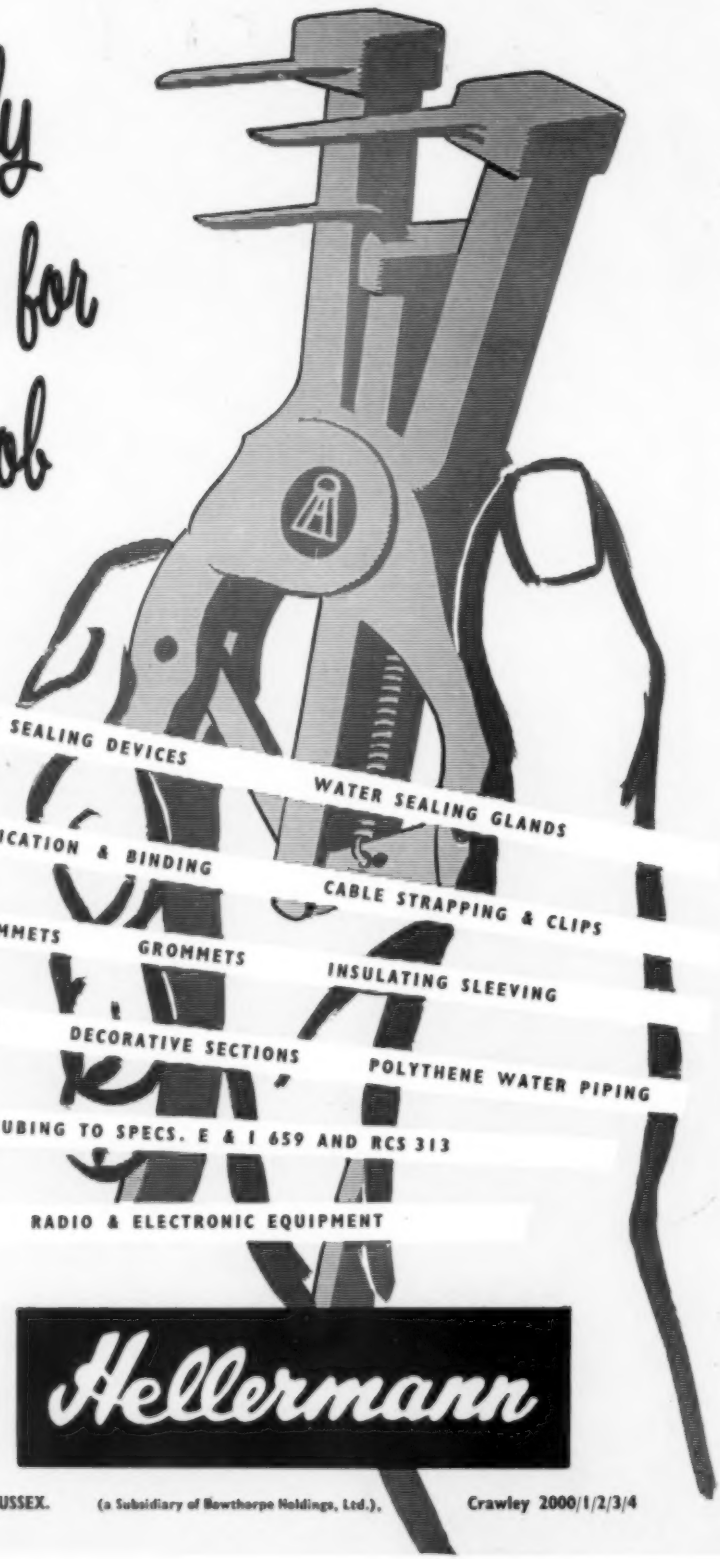

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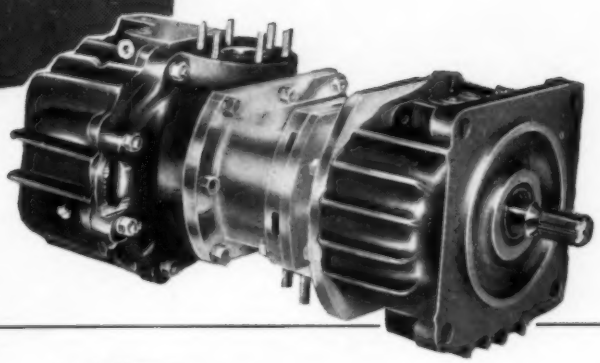

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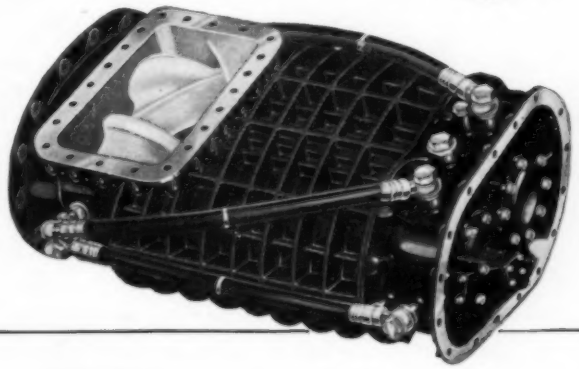
Godfrey/SRM Freon Pumps for airborne vapour cycle cooling systems are light and compact . . . mechanical, electrical and air turbine drives are available.

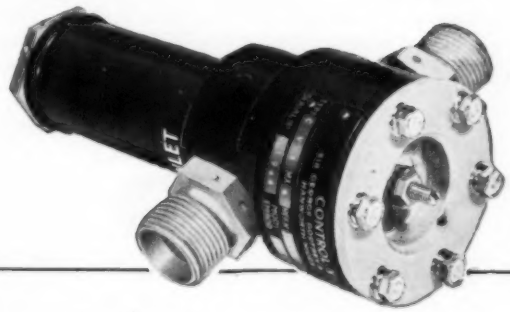
CABIN SUPERCHARGERS

To supplement the existing range of Roots type machines, Godfrey/SRM Cabin Superchargers are under development. These superchargers can operate at higher pressure ratios than the Roots type, they are also free from the surge troubles inherent in the centrifugal.



FLOW CONTROL VALVES

The range of Godfrey Flow Control Valves now extends from the Type CV-1 for ventilated suit air supply systems, capable of handling flows of approximately 42 cfm, to the Type CV-18 a stainless steel valve designed for air mass flows of 18 lb./min. at a maximum temperature of 350°C.



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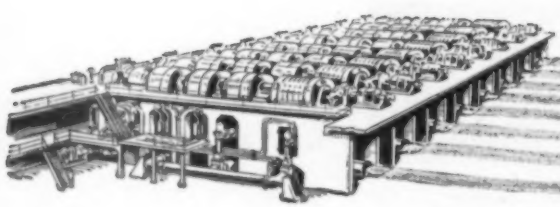

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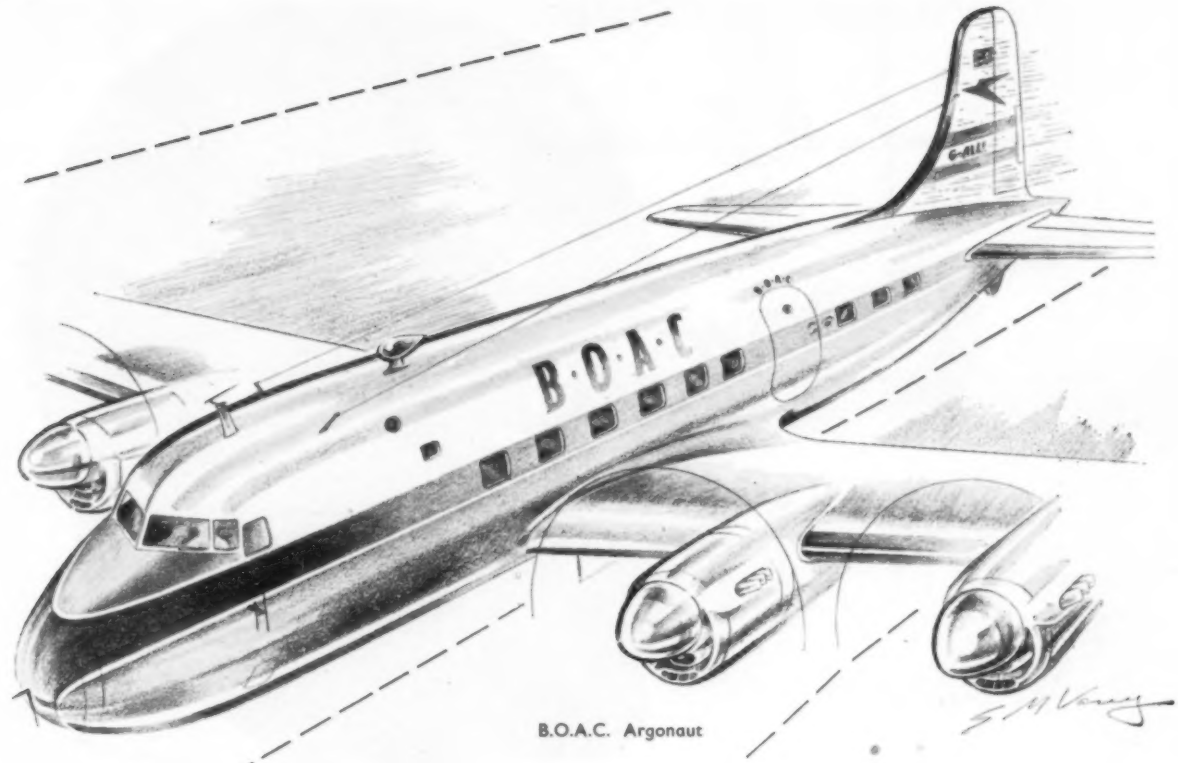

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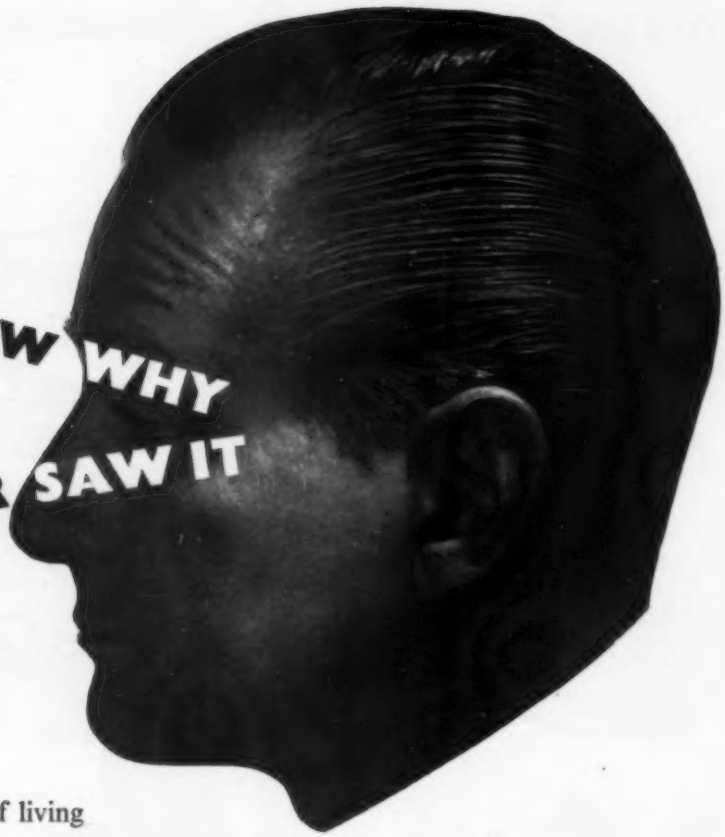

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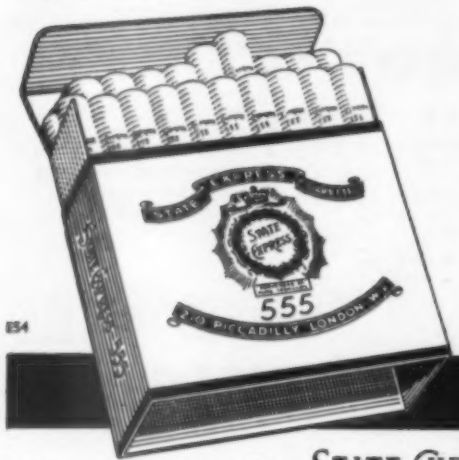

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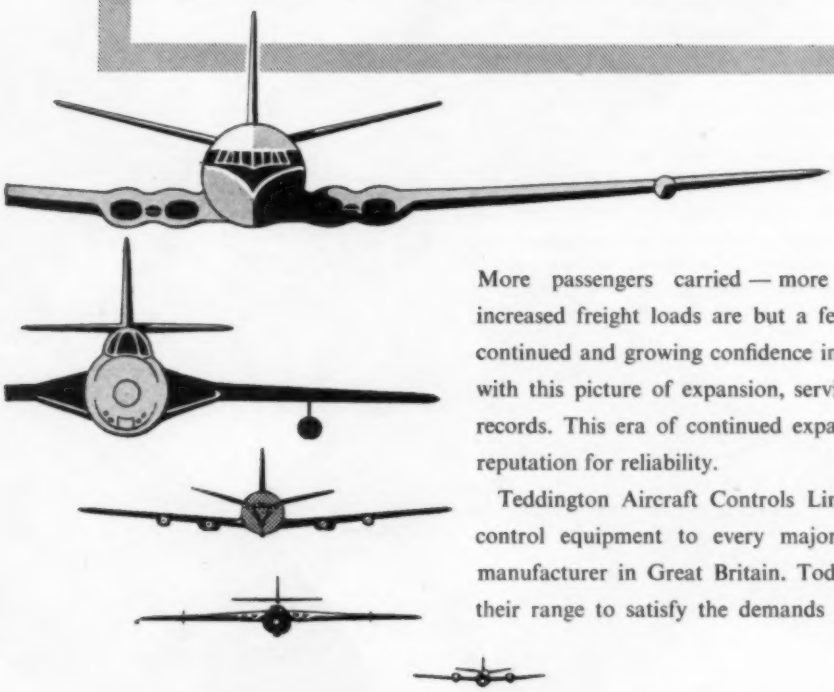

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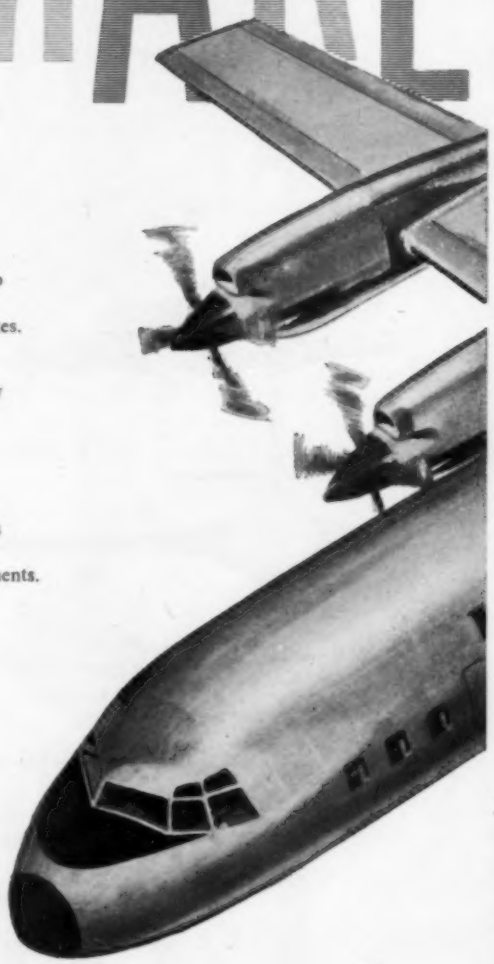

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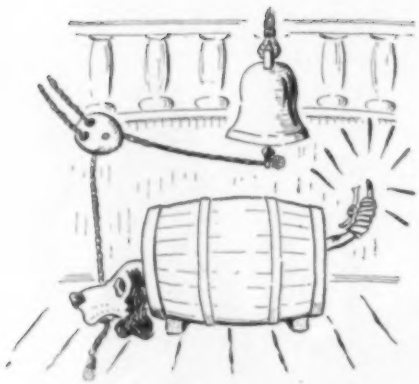

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WHO INVENTED THE FIRST CHRONOMETER?

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IN THE MEANTIME an unknown inventor, John Harrison, began to solve the problem of a reliable clock to maintain Greenwich Time at sea, and in 1764 his famous "fourth chronometer" successfully completed its trials on a voyage to Jamaica, to earn him the prize of £20,000.

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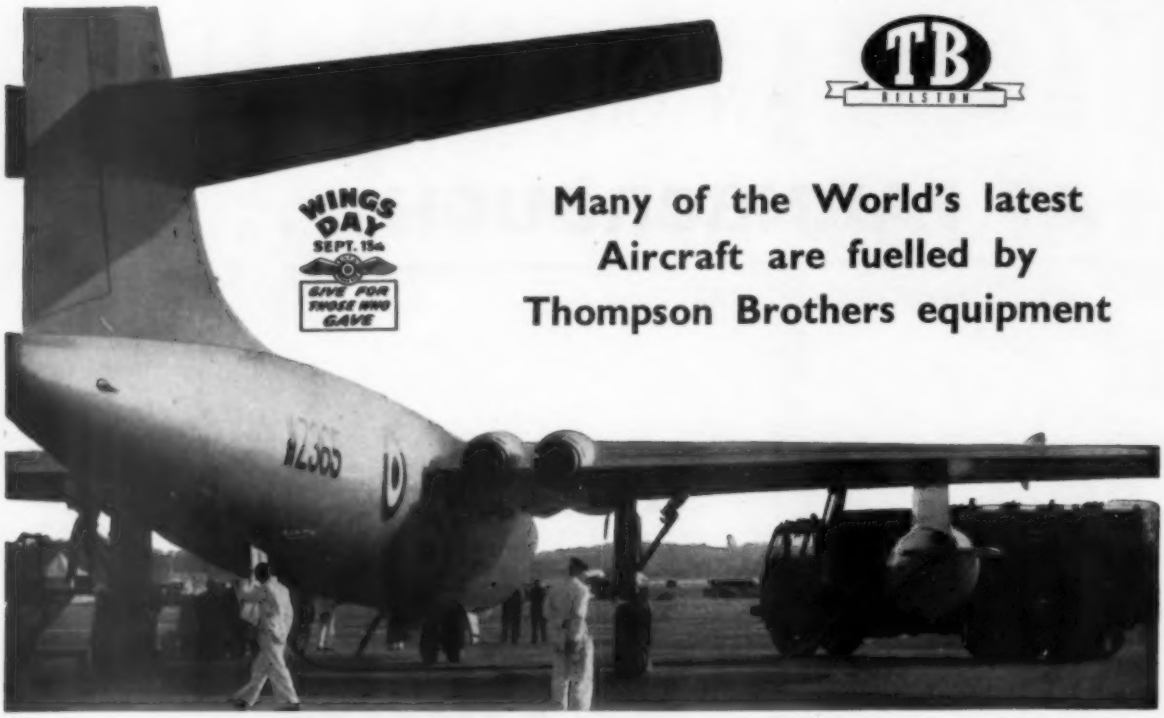

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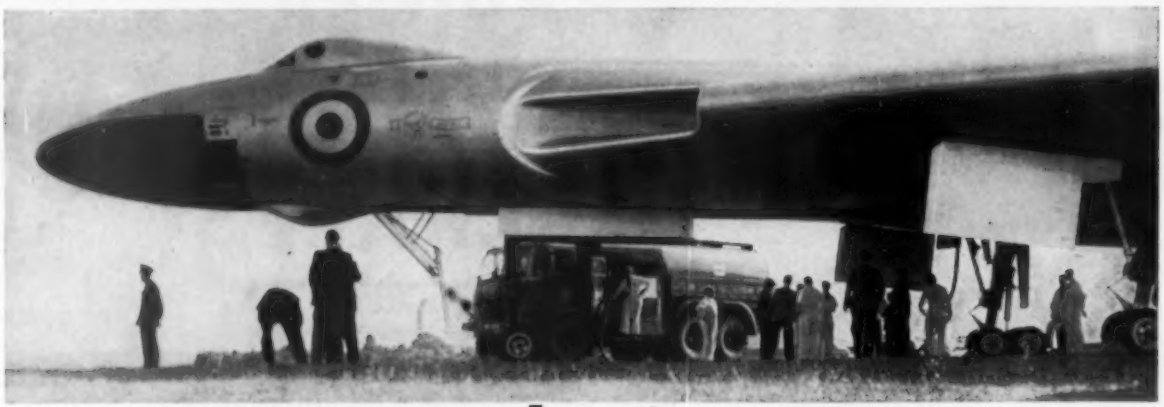

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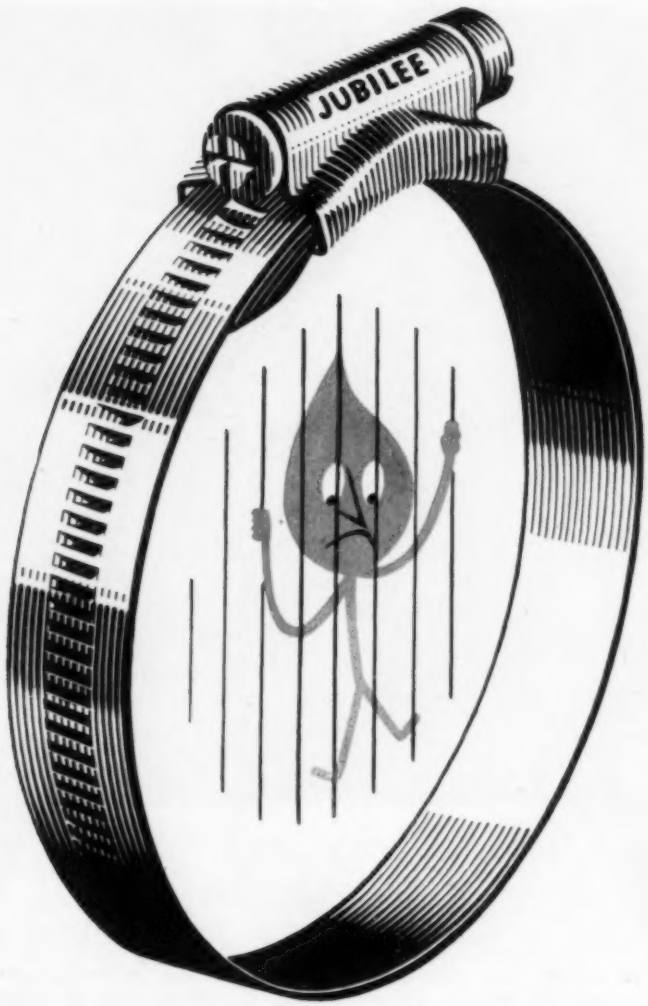

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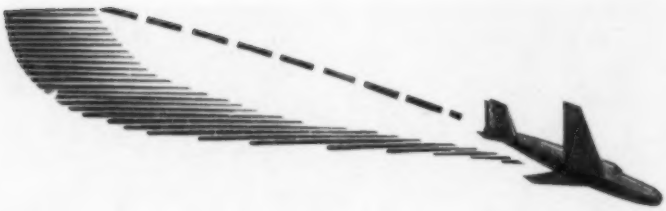

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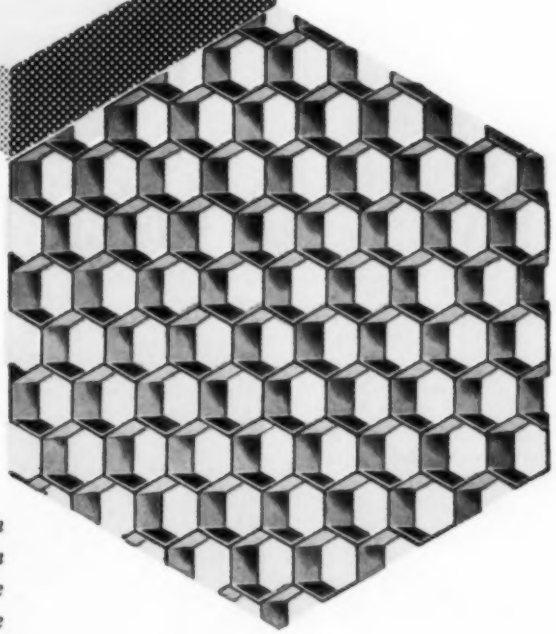

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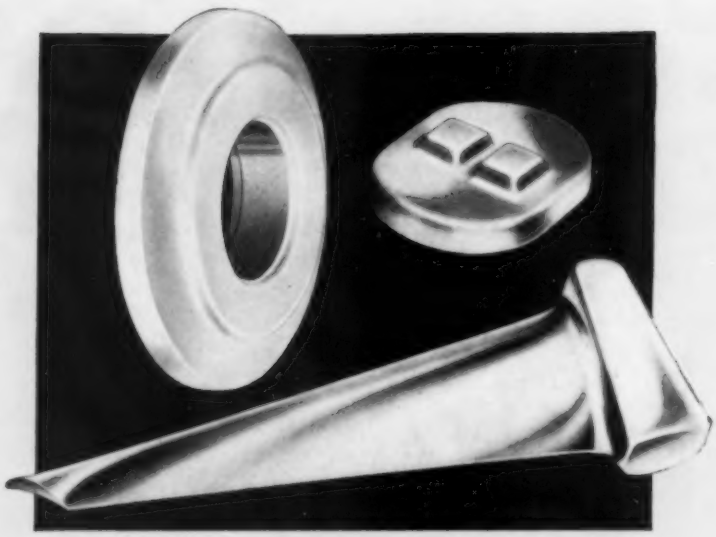

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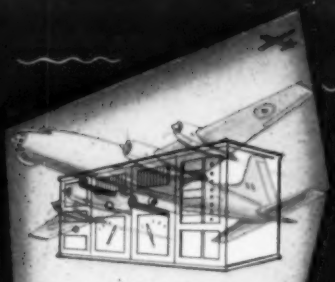
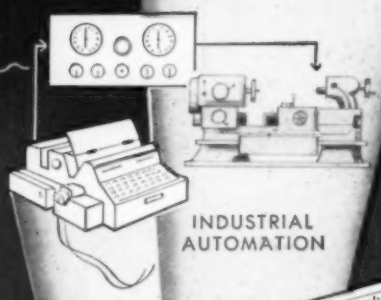
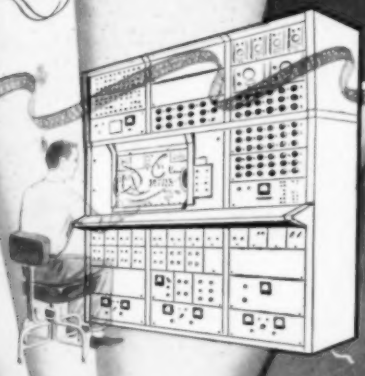


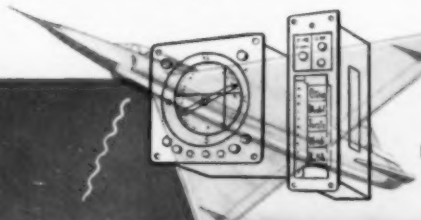
SIMULATION



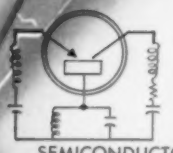
INDUSTRIAL AUTOMATION



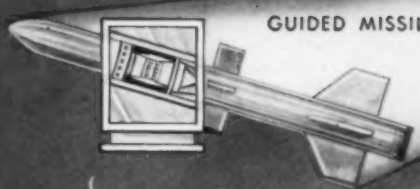
COMPUTERS



AIRCRAFT INSTRUMENTATION



SEMICONDUCTOR APPLICATIONS



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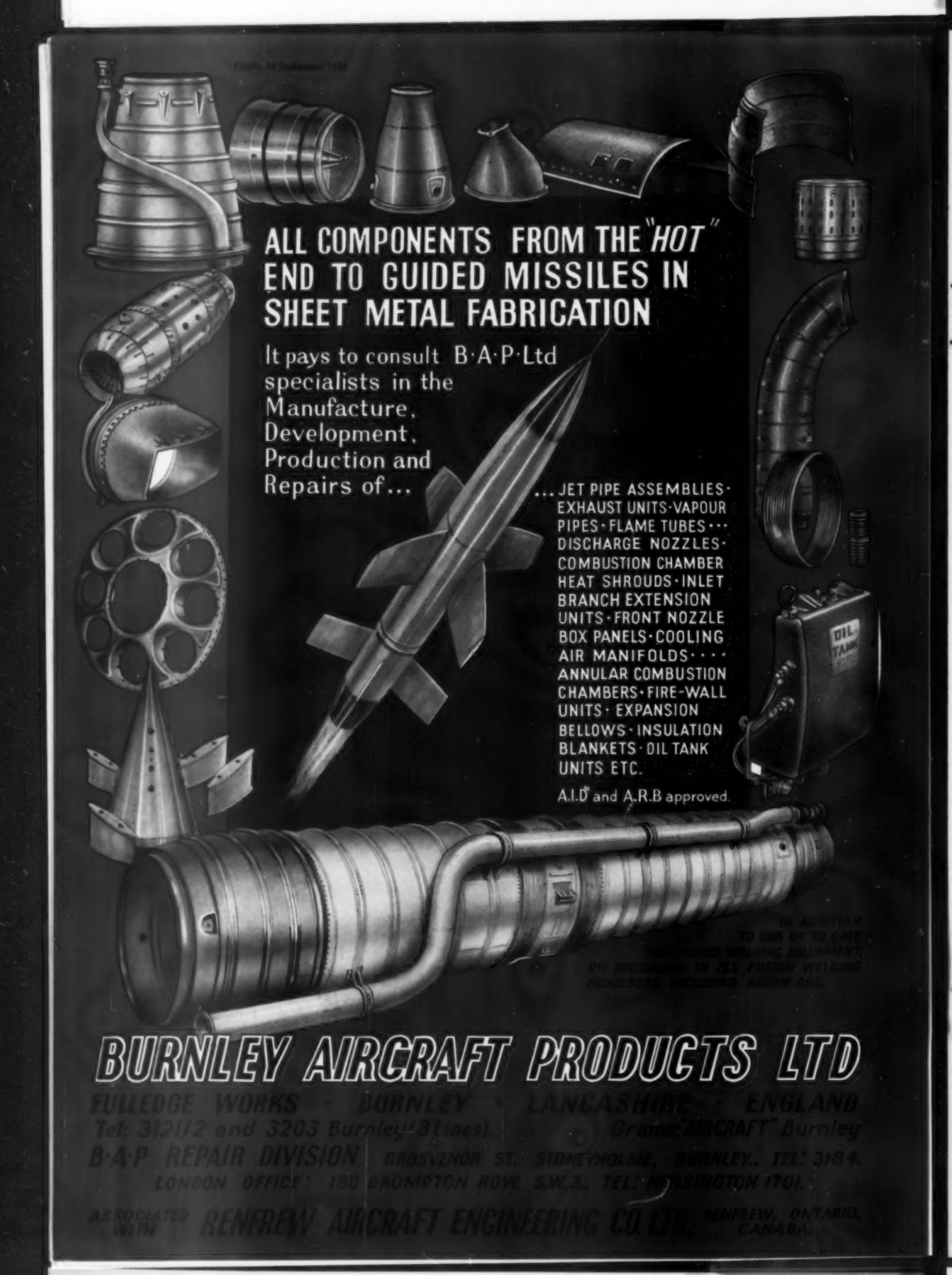
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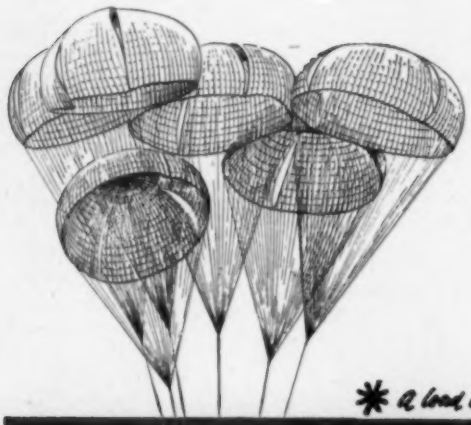

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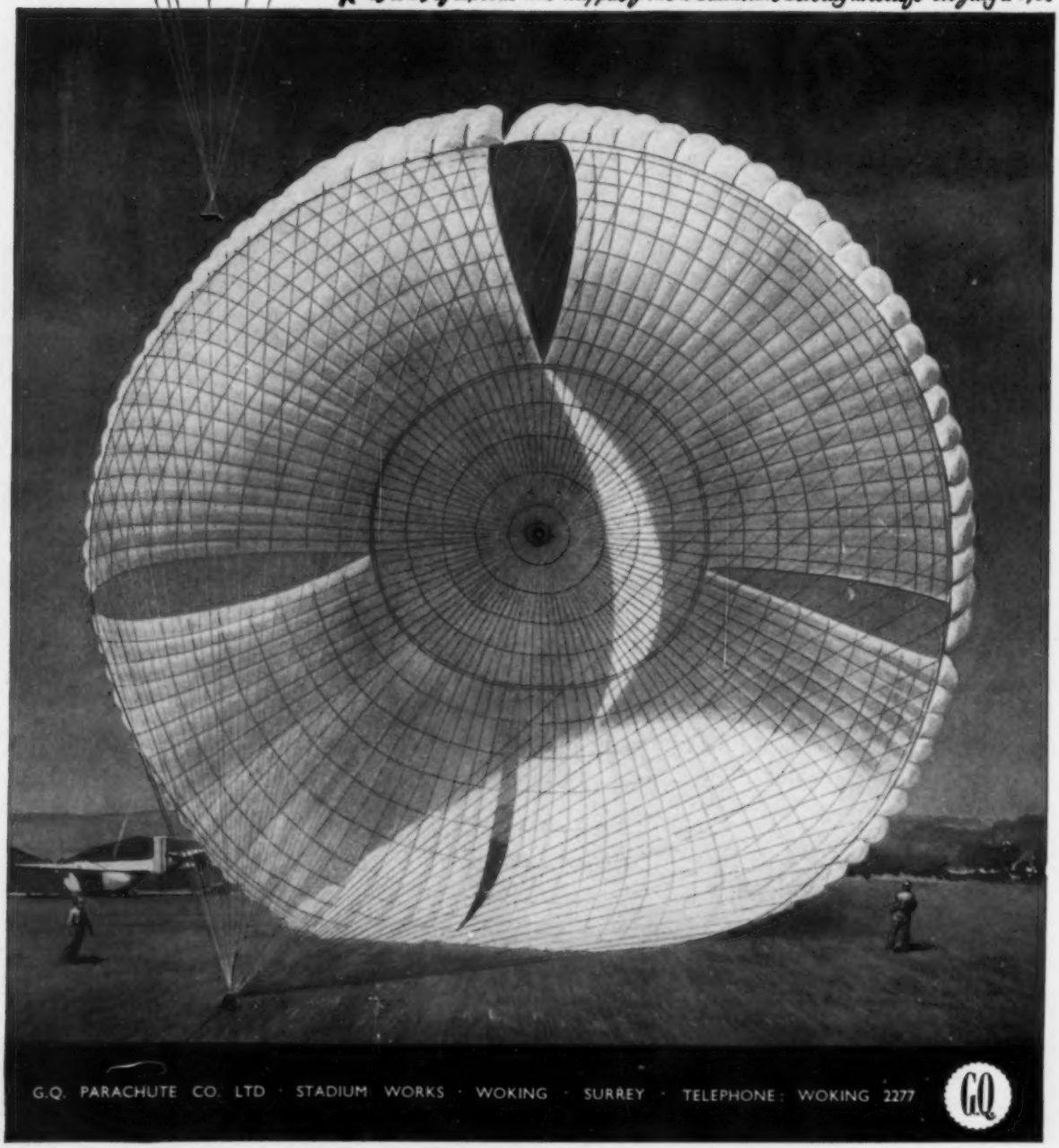

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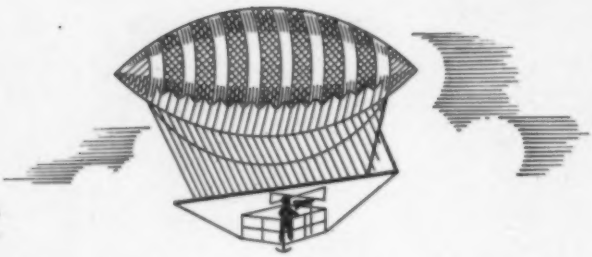

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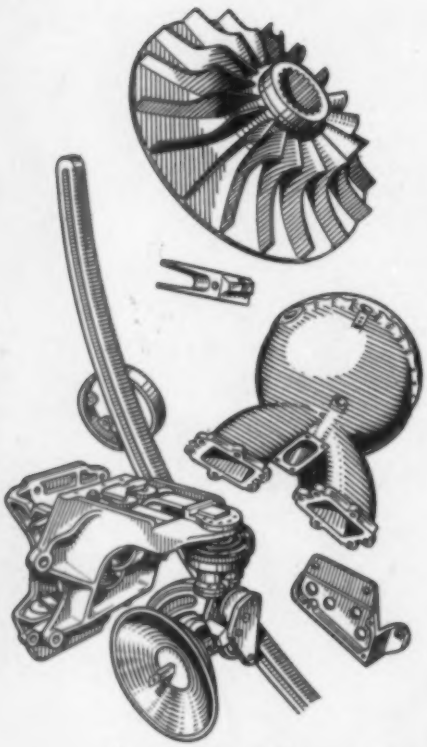

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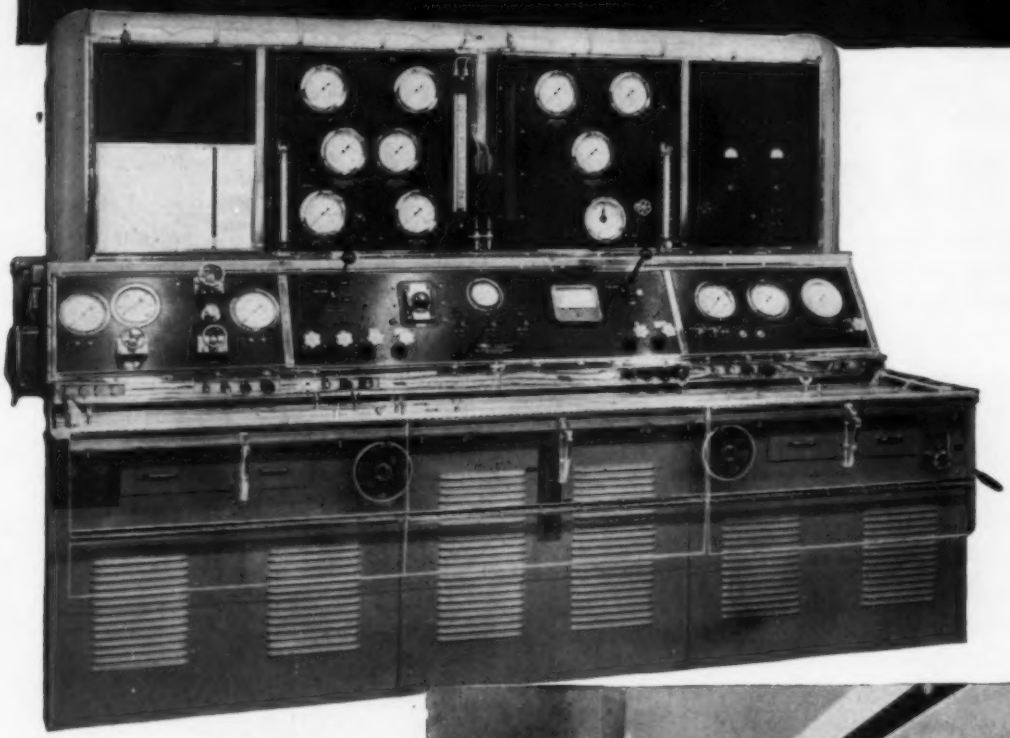

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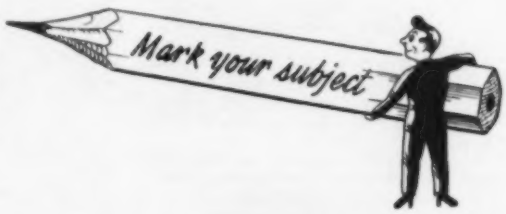

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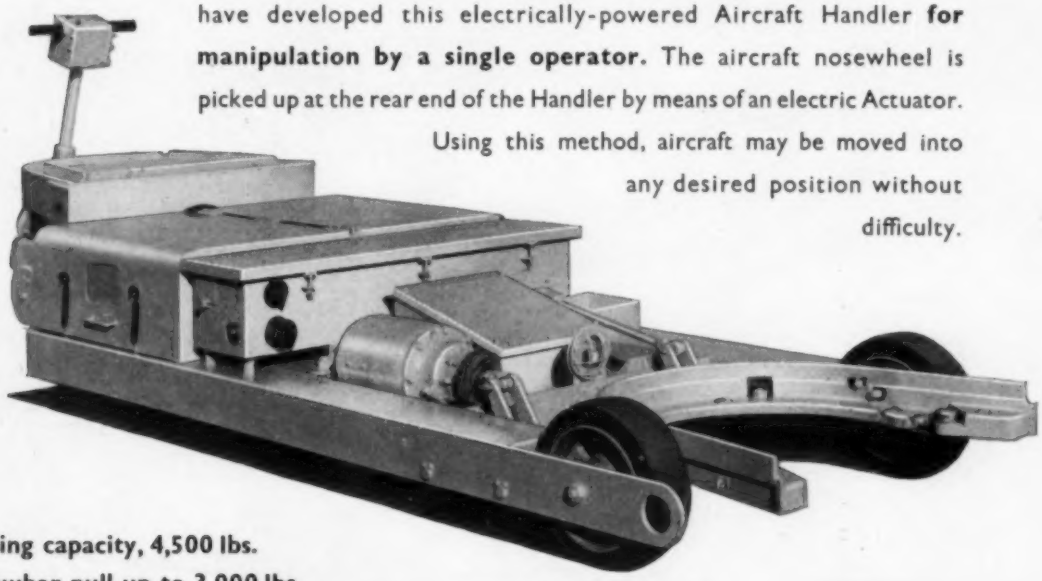

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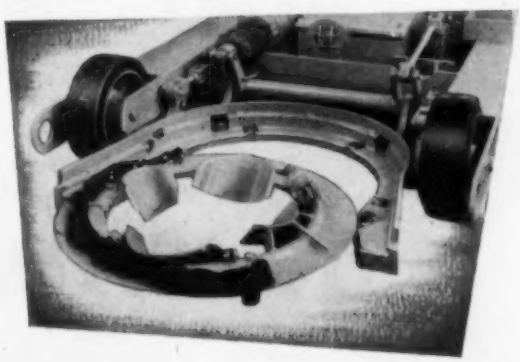

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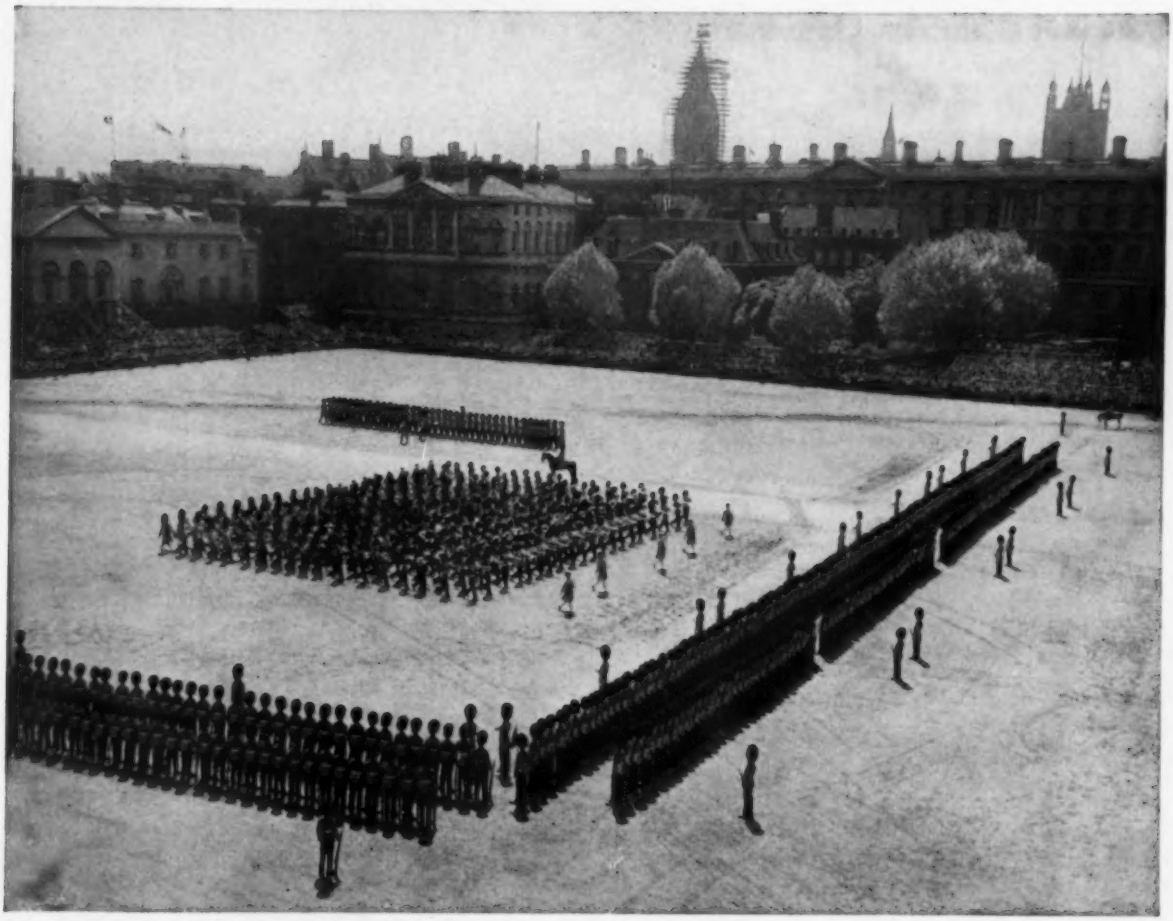

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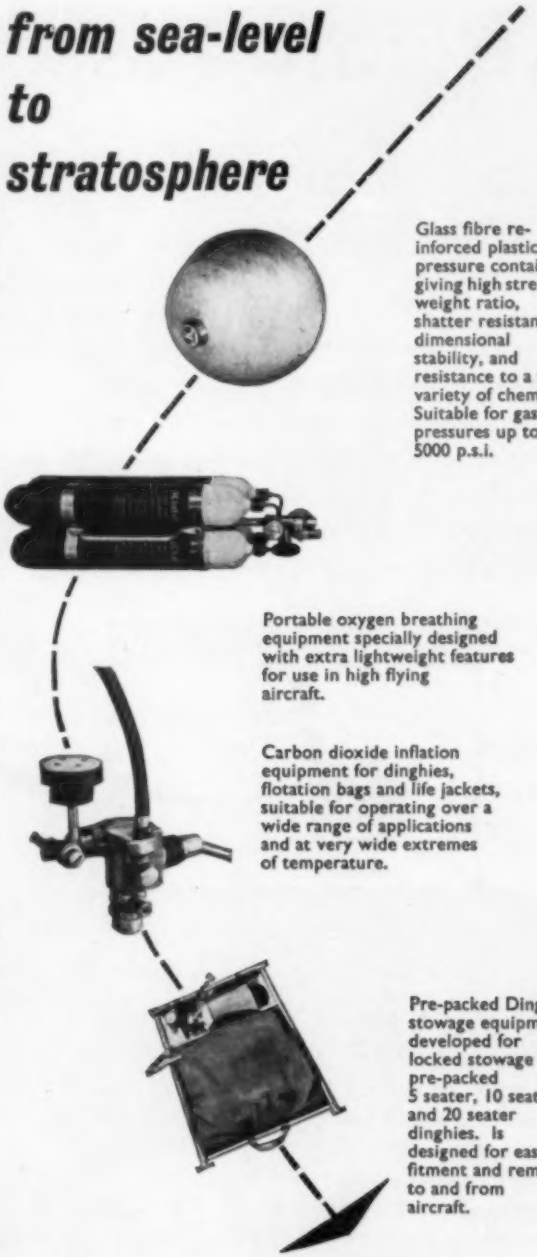

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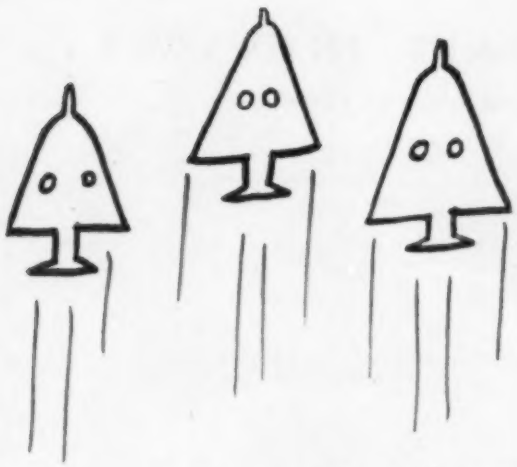

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An Attitude of Mind

TO attempt to justify something is, indirectly, to indict it. Nevertheless we shall say of the seventeenth S.B.A.C. Display that its value was not to be measured by the individual sales it has secured or may secure, but by the cumulative impact upon the commercial world of an industry which is out to sell literally any type of aeronautical product.

The impression Farnborough gives is of an industry which means business; and anyone who naïvely suggests that aeroplanes are not sold by being made to perform circus antics in front of a crowd overlooks one simple fact. This is that the Farnborough exhibition is essentially a trade show (which could just as easily be held in London) wrapped in the glamorous and alluring raiment of the world's finest air display. Because aeronautical products are not consumer-goods sold over the counter, they are best sold by the attitude of mind, exemplified by the S.B.A.C. Display, which makes the customer think to himself, when he has to choose between their products and those of a rival industry, "these firms are on the ball."

Thus at the twelfth conference of the International Air Transport Association which opens in Edinburgh on Monday (it is being attended by nearly everyone who is anyone in world air transport), we can be sure that our American friends will lose no opportunity of reminding the delegates that they mean business—big business—in the supply of transport aircraft; we shall see their sales-promotion at work in the most effective, imaginative and subtle manner. Yet so far as we know only one British firm is really on the ball for this particular opportunity. Is there a place for traditional British modesty ("we don't go in for that sort of thing") in the aviation sales business?

An aeronautical product may be unbeatable, but it will not always sell on technical merit or through normal sales efforts alone. "Thinking big," as exemplified by the S.B.A.C. Display, is the essential philosophy; and we would like to feel that it is applied wherever there is an opportunity—not only by airliner-builders at an I.A.T.A. conference, but by accessory makers at, say, a symposium on grommet bungs.

Showmanship and Salesmanship

It was with these thoughts that, towards the end of the recent display, we made a critical survey of the indoor exhibition from the point of view of display and presentation. Encompassed within the uniform but businesslike standards prescribed by the S.B.A.C., the exhibits were presented in widely varying degrees of taste and artistry. Despite the multiplicity of the industry's products, however, it is not impossible to generalize about their presentation.

The size of stand of course controls the theme: but whether it be large or small, the temptation to clutter it with too many exhibits, caption-boards, diagrams and photographs, and to obstruct it with high panelled surrounds, could with advantage be resisted. More stands might have had an arresting focal point (or a series of them, depending on stand-size) distilling the very essence of the product concerned. We particularly admired the masterly Dowty and Saunders Valve displays of flow-systems; Folland's miniature Gnat factory; de Havilland's commanding display of the executive-Heron interior; Thorn's relays at work; Murex's large colour-transparencies; and Lockheed's brilliant exposition of hydraulic gear back-lighted in blues, ambers and reds. Colours, furnishings and flowers—all subtle and dignified eye-catchers—were used with taste by few; Alvis and Boulton Paul were notable exceptions.

Trivialities? We do not think so. Such details betoken the attitude of mind which, on the grander scale, sells aeronautical products.

FROM ALL QUARTERS

Delta Down Under

ON the first overseas flight to be made by this type, an Avro Vulcan left Boscombe Down, Wilts, last Sunday for Australia, where it will take part in Air Force Commemoration Week celebrations. It will also fly to New Zealand before starting the return journey on September 24. The total distance to be covered is about 26,000 miles.

The first stage, to Aden, circumnavigating Egypt, was covered in 7 hr 18 min; a distance of 3,400 miles has been quoted, which would give an average speed of about 466 m.p.h., but it may well be that the diversion made the stage considerably longer than 3,400 miles. The second stage, from Aden to Singapore, was covered at 491 m.p.h. against headwinds of over 60 m.p.h.

As we go to press it is learned that the Vulcan reached Melbourne in a flying time of 23 hr 9 min (over 500 m.p.h.)

Acting as second pilot in the crew of five was Air Marshal Sir Harry Broadhurst, A.O.C-in-C. Bomber Command. Aircraft captain was S/L. D. R. Howard and other crew members were S/L. E. J. Eames and S/L. J. G. W. Stroud, navigators, and S/L. A. E. Gamble, air electronics officer.

Progress of the first day's flight was followed by Mr. G. Whitehead, chief design engineer of A. V. Roe, Ltd., with an H.F. radio in his house near Manchester. He picked up the aircraft's transmissions from as far away as the Mediterranean.

The Hustler

REPRODUCED below is the first published photograph of the Convair B-58 Hustler, the first supersonic bomber in the Western world. The design of this remarkable aeroplane is one of the greatest achievements of the American airframe and engine industries and has required the solution of problems not previously faced.

More than any other aircraft, the B-58 is a weapons system of which the aircraft itself is but a part. The system includes air-to-ground nuclear weapons, guided and otherwise, reconnaissance installations, electronic countermeasure equipment and even interception gear. We expect to publish an analysis of the aircraft in our next issue.

"Back in the Big League"

TRANSATLANTIC praise for the British aircraft industry appeared in the international edition of *Newsweek* for September 5 published midway through the S.B.A.C. Display. Commenting that the industry "had made an amazing come-back in the past two years," the magazine went on: "Besides proving that the British aircraft industry is back in the big league, this year's Farnborough Show demonstrated that modern air power means jet liners as much as jet bombers, executive monoplanes as well as supersonic fighters."

Newsweek listed the Viscount, Britannia and Comet as British export successes, and said that smaller aircraft such as the Dove, Heron, Herald and Twin Pioneer were going to "Britain's best market in the U.S."—business executives whose aeroplanes fly more in a year than all the scheduled airlines put together.

The magazine summed up by saying: "Of 880 jet and turbo-prop airliners now on order in the free world, 456 will be made in Britain." It added that "The R.A.F. has acquired new nuclear striking power," and went on to say: "The challenge is a formidable one, even to the U.S., now that the British have realized their mistakes in trying to build everything, instead of specializing in a few main types and getting down to mass production."

Soviet Visitors

APART from their visit to Farnborough—referred to in our Show report in this issue—the delegation from the Soviet aircraft industry visited an airframe factory and also the works of a well known engine constructor.

Headed by P. V. Dementiev, the Minister for the Aircraft Industry (he also holds the rank of lieutenant-general in the Soviet Air Force), they flew on September 6 from Vickers-Armstrongs' Wisley Airfield to Hurn, near Bournemouth, where they saw the Viscount production line. They spent about two hours in the works, and at the end of the tour Mr. Dementiev remarked to one of his hosts: "Your Viscount is a very fine aircraft."

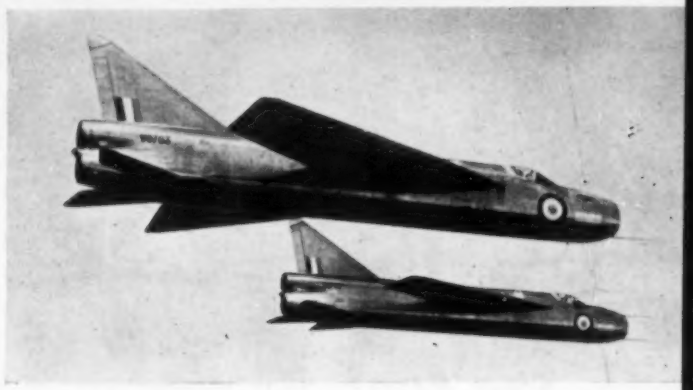
The engine factory, which members of the delegation visited on the following two days, was the Brockworth, Glos, works of Armstrong Siddeley (Brockworth), Ltd. In company with Mr. Dementiev were G. P. Svishchev, aerodynamicist and specialist in engine research and development; and O. K. Antonov, the well known designer of utility and transport aircraft. The visitors were accompanied by A.V-M. H. D. McGregor, Assistant Controller of Aircraft, Ministry of Supply; Mr. L. R. Beesly, Director of Engine Production, and Dr. J. Remfrey, Assistant to the Director of Engine Research and Development, also of the Ministry of Supply.

The Russian guests were entertained to dinner on the evening of the 6th at the Queen's Hotel, Cheltenham. Mr. H. Burroughes, deputy managing director, Hawker Siddeley Group, presided as host and Mr. H. T. Chapman, managing director of Armstrong Siddeley Motors, Ltd., and Mr. J. E. Attwood, director and general manager of Armstrong Siddeley (Brockworth), Ltd., were also present.

On the following morning, the delegation was conducted on a

VULCAN FORGES A LINK: A paragraph on this page records the departure of an Avro Vulcan for Australia and New Zealand. Here, on that occasion, are S/L. J. G. W. Stroud; S/L. A. E. Gamble; Air Chief Marshal Sir Dermot Boyle; Air Marshal Sir Harry Broadhurst; S/L. D. R. Howard; and S/L. E. J. Eames.

SUPERSONIC QUAD: Referred to in a paragraph above, the first Convair B-58 Hustler is here seen on the company's apron at Fort Worth, Texas, before ground running of the four General Electric J79 turbojets.



***SUPERSONIC TWINS:** The McDonnell F-101A Voodoo on the right is carrying "an external test shape" to simulate either fuel or bomb-carrying capacity. Of the two English Electric P.1 prototypes below it, the nearer has been used for armament tests and one of the gun ports is visible in the forward decking.*

three-hour tour of the Brockworth works by Mr. Attwood. This factory is one of the most modern and complete examples of an engine-production plant in this country as, after being taken over at the termination of prefabricated-house manufacture, it was completely stripped and replanned for the large-scale manufacture of the Sapphire. At present the factory is engaged on the production of the ASSa.7.

Almost half the time occupied by the tour of the works was spent in Engine Assembly. Keen interest was shown in this department by the Russian visitors, in particular by Mr. Dementiev and Mr. Svishchev, who are obviously familiar with the problems of engine production and asked many questions. They were also shown machine shops, the investment-casting foundry and the test-beds, where Mr. Dementiev at his own request was allowed to take over and handle the power control of an ASSa.7 on test.

During their tour, the visitors frequently expressed their view of what they saw as being "very good," an assessment that they were obviously technically competent to make, even if the intention was merely diplomatic.

Concurrently a Soviet Air Force delegation, headed by Chief Marshal of Aviation P. F. Zhigarev, visited four R.A.F. stations as well as going to Farnborough. They were also entertained to lunch at the Savoy Hotel, London, by the Air Council.

Their first R.A.F. visit was to Honington, Suffolk, on September 6, to see a Bomber Command station at work. The eight-man Russian delegation arrived by Valetta from Northolt and during their tour saw a static show of the resident Canberras plus Hunters, Javelins and Valiants. They then watched a flying display by all these types of aircraft, with a single Valiant doing a take-off and steep climb.

From Honington the Russians flew to Manby, Lincs, where they stayed the night at the R.A.F. College. On the morning of September 7 they paid a brief visit to Cranwell, then flew to the Central Flying School at Little Rissington, Glos. Here their stay was also short. An elaborate tour which had been arranged was abandoned so that the delegation could return to attend a conference at their embassy in London.

Up to last Sunday night, neither Soviet radio programmes for home listeners, nor Soviet newspapers, had reported on the activities of the Soviet visitors. Only the radio broadcasts for abroad briefly mentioned the delegations' departure from London in the TU-104, though not their arrival in Moscow.

A. V. Cleaver Leaves de Havilland

IT is announced that Mr. A. V. Cleaver, F.R.Ae.S., chief engineer (rockets) of the de Havilland Engine Co., Ltd., has relinquished his appointment as from August 31. Mr. F. M. Owner, C.B.E., M.Sc., F.R.Ae.S., M.I.Mech.E., deputy chief engineer of the company, takes over the technical direction of the rocket division and Mr. W. N. Neat, A.F.R.Ae.S., continues to serve as deputy chief engineer (rockets).

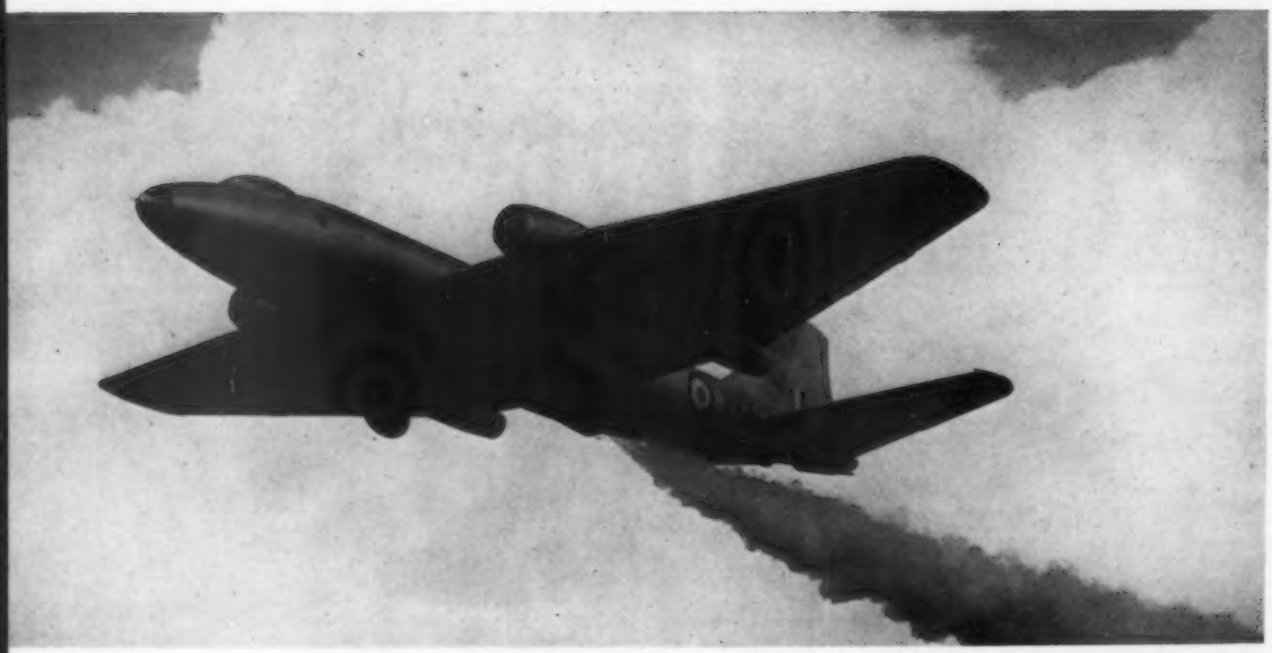
Mr. Cleaver has been associated with de Havilland rocket-motor activities since the end of the 1939-1945 war and it was during this period that the Sprite and Super Sprite liquid-propellant a.t.o. rocket engines were developed. In recent years Mr. Cleaver has been responsible for the D.H. series of Spectre rocket engines which, besides their a.t.o. application, are also being prepared for the new generation of military aircraft employing mixed-power-plant engine installations.

It is stated that "Mr. Cleaver leaves the company with the best wishes of the directors and his colleagues."

R.A.E. Appointments

THE Ministry of Supply recently announced the following appointments at the Royal Aircraft Establishment, Farnborough: Mr. E. C. Cornford to be Head of Guided Weapons Department, Mr. D. J. Lyons to be Senior Superintendent, ballistic missiles division of the Guided Weapons Department; and Mr. P. A. Hufton, Senior Superintendent, supersonics division of the Aerodynamics Department. All three have all been promoted deputy chief scientific officer on taking up their new appointments.

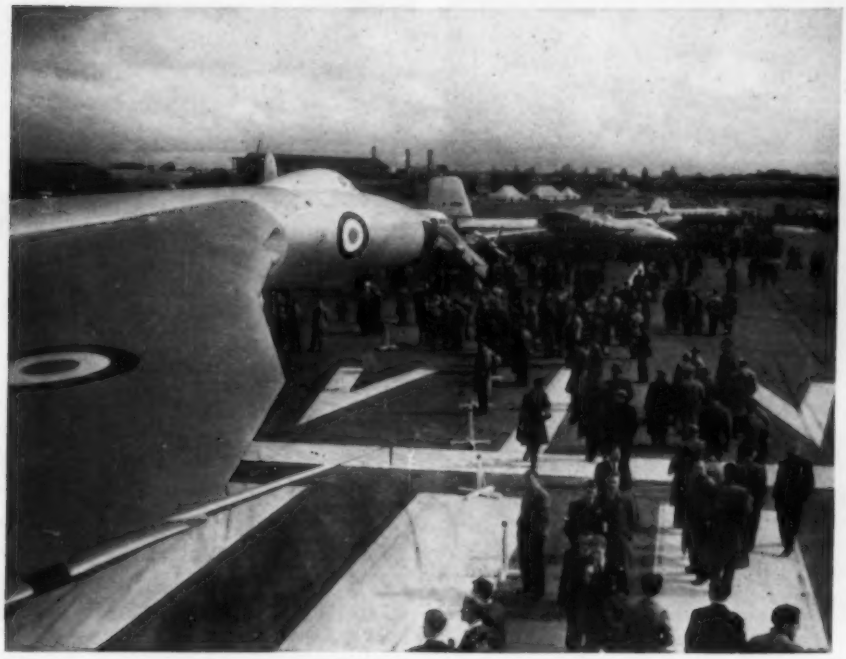
***WELCOME GUESTS:** on the left, Chief Marshal of Aviation P. F. Zhigarev, Commander-in-Chief of the Soviet Air Forces, is seen inspecting the guard of honour on his arrival last week for a visit to Royal Air Force Station, Honington. The delegation viewed aircraft on the ground and witnessed a flying display. On the right, at the Armstrong Siddeley factory at Brockworth (see news item "Soviet Visitors" opposite):— G. P. Svischev, aerodynamics and engine research expert; Mr. L. R. Beesly, D.Eng.Prod., Ministry of Supply; Dr. J. Remfrey, Eng.R.D.I., M.o.S. (partly concealed); A.V.-M. H. D. McGregor, Assistant Controller of Aircraft, M.o.S.; Mr. W. Drakeford, works manager, Brockworth; Mr. J. E. Attwood, Armstrong Siddeley (Brockworth) director and general manager; P. V. Dementiev, Soviet Minister for the Aircraft Industry; Mr. A. J. Bangs, contracts manager, Brockworth; Mr. J. E. Marriott, production engineer, Brockworth; O. K. Antonov, designer.*



The Four Elements

Twin Napier Scorpion liquid-rocket barrels on the English Electric Canberra B.2 WK 163 light up with a spurt of steam as this flying test-bed gets under way for a Farnborough demonstration. Below, twin de Havilland Super Sprite liquid-fuel rockets are seen assisting Vickers-Armstrongs Valiant B1 WB 215 (the second prototype) from the wet runway. The Super Sprites add 8,400 lb thrust to the 40,000-odd lb delivered by the four Rolls-Royce Avons.

FARNBOROUGH WEEK



An Illustrated Day-to-Day Record of the 17th S.B.A.C. Display and Exhibition from Tuesday, September 4, to the closing of the Show, with additional notes on the Aircraft.

ILLUSTRATED MAINLY WITH "FLIGHT" PHOTOGRAPHS

THERE was no doubt about it, the weather had won. From the morning of Monday when, as we reported last week, the clouds began ganging up like Teddy boys, to the end of Sunday's display, when the rain-sodden public began to queue their way home, it had been grey skies and dampness all the way at Farnborough. Only Saturday provided a warm and dry respite—a flash in the pan, as the Met. Office pointed out, but a flash at least that boomed with the sound of the Fairey Deltas' Mach joust at height—even if the sight of the joust was obscured by the decorative outlines of the vaporous Teddy boys.

Following Monday's "preview" display, fully described in last week's issue, the flying programme was modified on Tuesday to provide an improved and more logical presentation. Even before the flying display, however, a basic difference was evident in Tuesday's Farnborough mixture. The new ingredients were seen in the people attending—the sea of people which half-covered the tented exhibits and then flowed down the hill to lap in waves against the roped-off islands on which were parked the statically displayed aircraft. Among the visitors, appropriately enough, more foreign uniforms were seen, together with more stripes on uniform sleeves and stars on shoulders; more foreign tongues were heard; and more-expensive brochures were transferred to more-important-looking briefcases. Perhaps it was an illusion, however, that the cigar-smoke wafting across from the exhibitors' crowded enclosures today had a more expensive aroma.

Tuesday morning was dry if overcast, and there was much for the guests—who seemed to include a noticeably large contingent of Canadians—to see. In the static aircraft park the Supermarine N.113 and the Bristol Britannia 301 were now on view, in addition to Monday's selection. Among the V.I.P.s this day were the Minister of Supply, the Chief of the Air Staff, and the much-publicized Russian industry delegation led by Mr. P. V. Dementiev, the Soviet Minister for the Aircraft Industry.

The day's flying display began with the Beverley and the engine test-beds, as on Monday but with the inclusion of the Orion Britannia. The order of R.A.F. participation was reversed, the Canberra T.4s of 231 O.C.U. preceding the helicopter group and the Hunters of 43 Squadron following it. The order of the individual demonstrations which followed had been changed, giving a snappier show with fewer gaps than on Monday. The penultimate item was to be the Britannia 301—its only appearance that week—and the two Fairey Deltas, in their restricted low-level demonstration, would end the display (apart from the passenger flying in the Herald, Twin Pioneer, President and Britannia).

Items of information disclosed during the afternoon commentary were that the Canberra P.R.9 had been consistently flying at heights comparable to the existing world record (65,890ft); and that the Folland Gnat had completed the first phase of gun-firing trials at 40,000ft.

The incident which was presented to the British public at their breakfast tables next day under headlines such as "JET TWISS SAVES DROOPY" occurred as Peter Twiss was taking off in WG 774, his record-breaking F.D.2. As he applied reheat early in the take-off run, the cluster of three braking parachutes accidentally streamed from the tail of the machine. Twiss continued along the runway without reheat, but was heard to apply afterburning again before leaving the ground. The tail parachutes were jettisoned after take-off, and Twiss and Slade carried out their low-level display as planned.

At a Press conference following the display, Mr. Dementiev, the Soviet Minister for the Aircraft Industry, was asked whether Russia had plans for an attack on the F.D.2's speed record of 1,132 m.p.h. He replied that Russia possessed aircraft which could fly "just as fast"; such speeds were widely accepted. A new turboprop transport which would carry 120-180 people, Mr. Dementiev said, was now under construction in the Soviet Union. He had been impressed at Farnborough by the organization and piloting skill involved, as well as by the aircraft and other exhibits. When asked how many people are employed in the Soviet aircraft industry, Mr. Dementiev gave an eminently quot-

Taking leave on the left from the M.o.S. Fairchild Packet (once again the photographic grandstand) is Vickers Viscount 802 R.M.A. "Sir Samuel White Baker." Taking a brisk shower below is the Hawker Hunter F.6 with R.P.s and drop tanks.

FARNBOROUGH WEEK . . .

able reply. "I know," he pronounced, "but I will not say." Members of the two Russian delegations were given a flight in the Britannia 301 before leaving Farnborough.

A particular attraction on Tuesday was the Supermarine N.113, which was to figure in both the flying and static displays during the week. WT 854 is the first prototype machine with an anhedral tailplane slab and large wing fences as its principal modifications. The massive tail bumper and arrester-hook installations under the tail were not faired. Considerable scorching was observable on the exposed faces of the jet efflux fairings. Close to these, two hefty strengthening plates have been riveted over the skin. It seems possible that the intake at the front of the dorsal spine serves a feel-simulation device; and another intake, under the tail, almost certainly performs a similar function. The spine itself is shorter than on the later prototype, WT 859, and has no plastic-covered spike radio aerial. A sharp waisting of the fuselage sides just behind the engines, which are themselves mounted well forward in the fuselage, suggests attempted area-rule compensation for the relatively thick wing. Refuelling and ground-power (120-volt) points are to starboard ahead of the wing. Inscriptions here indicate a fuel system similar in some respects to that of the Swift.

The whole wing leading edge droops, breaking the fences. Four underwing tanks shown in the static park, estimated to be of about 150 and 250 gallons capacity, have not been flown and were removed for demonstrations. The nose-cone of this machine is all-metal and hinges to port, presumably for access to test instrumentation. The canopy is of clear-vision type and a Martin-Baker Mk 4 lightweight ejector seat is installed. No gun-sight was in evidence and four cannon ports under the fuselage were semi-permanently covered. Six air-brake panels extend under the

Our photographer is thankful that "Dick" Whittington, in the Folland Gnat, did not turn again on this occasion. As can be seen, the Gnat skidded off the runway on touchdown and proceeded along the grass on the far side.

The rewards of simplicity

A common view prevails that to be effective the modern high-speed fighter must be large, heavy, complex and costly. The idea is old and has much historical support; the processes which gave rise to it began in aviation's cradle days, when even the primitive aeroplane revealed how far man's natural faculties fell short of his aerial ambitions.

Without a mechanical datum line a pilot does not always know his attitude. He must have an instrument to tell him his air speed, another by which to measure his turns, a third to tell him his direction, a fourth to give him his height, and others to record engine speed, oil temperature and pressure. His senses, alone, are too unreliable, too limited.

One by one these instruments were supplied, and after them came a series of technical developments — variable pitch airscrews, retractable undercarriages, wing flaps and supercharged engines—to increase the aeroplane's efficiency and—on the debit side—to add to its complexity, cost and weight. For even to maintain an existing standard of performance, power plant and fuel weight must be increased in proportion with weight structure and equipment; to improve performance a still larger proportion must be devoted to the production of "thrust". On both accounts a given payload has meant an even heavier and larger plane.

So performance improved, and flight in conditions that at one time would have kept the fighter grounded or imperilled its safety became possible. But by 1945 fighter weights had reached the 10,000 lb. level.

After the introduction of the turbo-jet engine with its almost unlimited power and thirst for fuel, fighter performance advanced with prodigious strides; so, too, did size, weight, complexity and cost. The trends followed historical precedent, and the compounded fee demanded for an expanding performance was deemed to be inescapable. It was paid without demur.

Not until 1951, when the cost of a fighter passed the £100,000 mark, was the "inevitableness" of growth successfully challenged in this country. In that year, a private aircraft company, on its own initiative and from its own resources, designed and later built the Gnat—a light fighter which reversed past trends. By ignoring all but essential equipment and armament and by concentrating intensive effort with the engine and specialist equipment makers to reduce the inevitable rise in cost, bulk and weight, the Gnat escapes the penalties of large size, heavy weight, bewildering complexity and high cost.

More than 200 hours of test flying with prototypes have proved that the Gnat has a performance equal and in many respects superior, to that of the conventional fighter. Yet it is only half the size and a third the weight.

Not foreseen, but now becoming apparent, is the resultant opportunity to provide modern defence in the air within the economic, technological and manufacturing scope of many countries who prize their freedom but whose resources are limited. In the air the logic of simplicity is unanswerable, and its acceptance brings its own rewards.

Folland Aircraft Limited, Hamble, Southampton, England

MOST ROOM IN THE SKY

In a recent Notice to Airmen the Ministry of Transport and Civil Aviation has given a lead to the world toward the solution of air traffic control problems. "**It is proposed to take advantage of the high accuracy of the Decca Navigation System to introduce procedures in the London Flight Information Region which will expedite traffic by employing reduced separation standards.**" The Ministry once again endorses the vital role played by the Decca Navigator, not only in accurate en route navigation, "*The United Kingdom believes that it is only by using Decca—with its area coverage, pictorial presentation and high accuracy characteristics—that the maximum flexibility, expedition and safety of air traffic can be assured.*" (Civil Aviation Information Circular No. 110), but now in permitting the close lateral and longitudinal separation of aircraft both on airways and in the London Control Zone. By this major step toward multi-track airways the Ministry recognises once again the accuracy and flexibility of the Decca Navigator System which in its new role will ease the load on both pilot and control officer, speeding the flow of air traffic and making the greatest use of the available air space.

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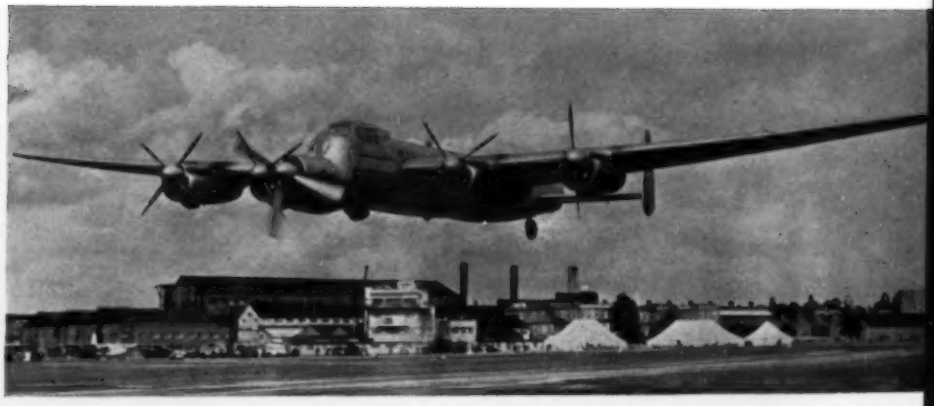
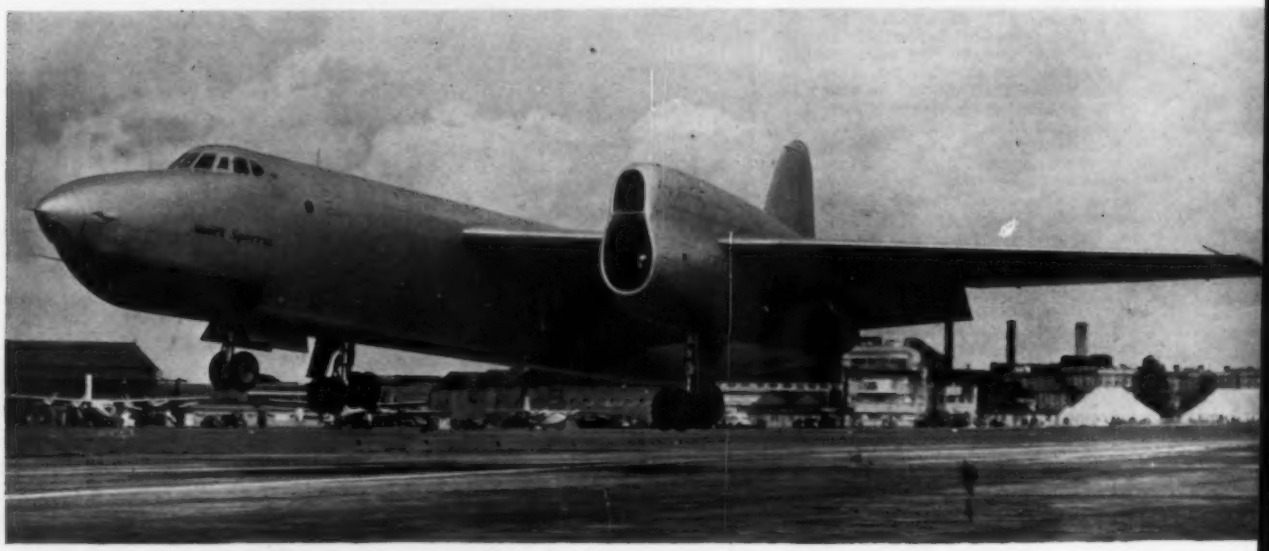
FARNBOROUGH WEEK . . .



At upper right, the Rolls-Royce Tyne-Lincoln is making a pass with all four Merlins shut down. Below it the Fairey Gannet A.S.4 presents itself with R.P.s, a sonobuoy dispenser, an air/sea-rescue pack, and—internally stowed—a 1,000 lb mine and more sonobuoys. The English Electric Canberra P.R.9 and the de Havilland Gyron-Sperrin are seen below under contrasting conditions.



FARNBOROUGH WEEK . . .

fuselage just ahead of the jet-pipe orifices. The undercarriage has Maxaret-fitted brakes.

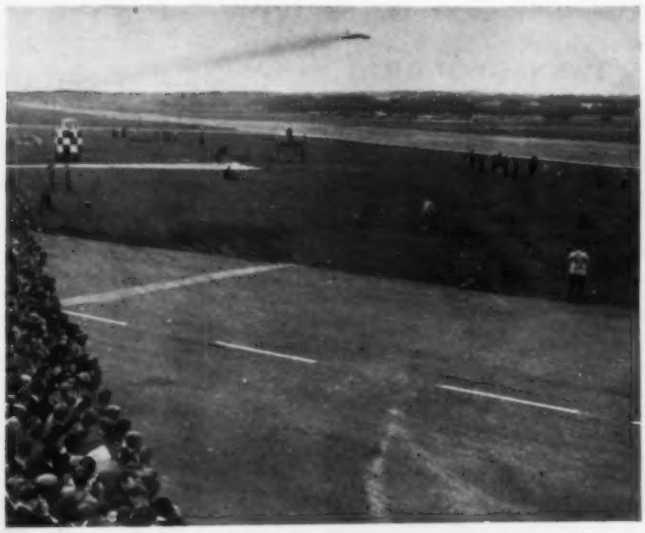
Optimism concerning the weather was again out of place on Wednesday, when the forecast included "prospect of fog." The flying programme was changed to a bad-weather routine, with the R.A.F. formation teams taking advantage of the improved conditions towards the end of the afternoon. The Victor, as well as the Britannia, had been deleted from the list of aircraft appearing, while the Fairey Delta demonstration was on this day a solo turn by Peter Twiss.

Following the display, one of the members of the Soviet Air Force delegation, led by Chief Marshal of Aviation P. F. Zhigarev, flew in the Hunter T.7 trainer with Bill Bedford, Hawker chief test pilot. He was Lt.-Gen. Alexei Blagoveshchensky, a senior Air Force test pilot and commandant of a Soviet flying school. After a trial circuit, the General took over for a second take-off, circuit and landing; and the subsequent flight included a supersonic dive over the sea. Special permission for the flight, the Hawker company stated, had been obtained from the Ministry of Supply.

Rain fell once more on Thursday morning, but conditions were good enough for the flying programme to proceed in the afternoon. An unusual incident involving the Folland Gnat occurred as "Dick" Whittington was bringing the agile machine in to land after his display. On touching down he streamed his braking parachute, which scooped up water from one of the large puddles which covered the runway. The added weight on the tail, together with the crosswind, caused the aircraft to skid and to veer on to the grass at the side of the runway. Whittington was unhurt and the Gnat was undamaged.

A three-day spell of English weather almost at its worst had greeted overseas guests to the 1956 S.B.A.C. Display and Exhibition. The flying demonstrations had been viewed through a wet and murky screen, from a wet and muddy field, yet they had impressed. Orders announced during the trade days had included nine Vickers Viscounts (for the Brazilian government, Lloyd Aereo Colombiano, P.L.U.N.A. of Uruguay, and T.C.A.), bringing Viscount orders up to 356; a number of Twin Pioneers for the Ministry of Supply; and two Westland Widgeons for Bristow Helicopters, Ltd. In addition,

(Centre, right) One of the rare moments of tranquillity during the Westland helicopter act, showing the Whirlwind between the two Widgeons. (Right) A study in area rule, provided by the mighty Supermarine N.113.



With Avon-smoke marking its passage, the Hunter 6 carrying four under-wing tanks flashes across from Laffan's Plain.

it had been announced that Air India had specified Rolls-Royce Conways for its three Boeing 707s; that B.O.A.C. had also named the Conway as the powerplant for its 707s, as yet unordered; and that Hunting Clan Air Transport had ordered one Britannia 310, with an option on two more.

THE PUBLIC DAYS

LIKE the way the world ends in T. S. Eliot's poem, Farnborough 1956 went out not with a bang but a whimper. It ended officially when, at the stroke of five on Sunday afternoon last, Jock Bryce took off his Viscount—not to show off its lines in most un-airline-like steep turns, but to disappear between the sodium lights and into thick autumnal mist over Laffan's Plain, heading for his home airfield, Wisley. What was left of a crowd of 125,000, who had valiantly and expectantly reached the S.B.A.C. Display that morning through rain as pitiless as an Indian monsoon, saw the Viscount depart; many thousands had already straggled to the station, or boarded their cars and coaches, since the flying display petered out at ten past four and aircraft which had not already flown were reduced to taxying down the waterlogged runway like so many mannequins displaying rainwear.

The pilots—heroes all, on this appalling day—had done their best to entertain their faithful public. Soon after one o'clock a Canberra was airborne to examine the weather; then a Skeeter did some entertaining waltzing up and down; next an R.A.E. Hunter (F/L. Geoffrey Shaw up) showed how absurdly easy it is to fly upside down when going very low and very fast; and at 2.45 Oliver Stewart announced that the official flying would start on time. It did; but within an hour the conditions had become almost too bad even for test pilots, so cancellation was not unexpected. The final word was not said until the four R.A.F. Canberras (so impressive on preceding days in their sleek formation) had been talked down singly out of the surrounding gloom, and until S/L. Gellatly had done his incredible stuff in the Fairey Ultra-Light (though he was in cloud below 1,000ft and almost invisible at the other end of the runway); then Oliver Stewart spoke the sad epitaph of Farnborough 1956: "It has been a terrible regret to all of us, this week of bad weather."

Regrettable indeed; for had the elements not been so unkind all week, this *might* have been a record Farnborough. On Friday, first of the public days, there were 14,800 people there, compared with 60,000 on the corresponding day last year. But by 10.30 a.m. the huge exhibition marquee was already quite crowded and, even though conditions were far from ideal, with gusting chilly winds and a 2,500ft cloud-base (the brilliant 43 Sqn. Hunters were disappearing into cloud in tight formation and coming out of it still tucked together), the flying programme was achieved—with the exception of the two F.D.2s due to essay a supersonic cross-over. Would they, we wondered then, be able to manage it at the week-end?

Saturday turned out to be nearly the sort of day we might have ordered—sunny and dry, and with a clear sky, though still a little unsettled-looking. Farnborough looked gay and carnival-like, its blue and white tentage, flags and banners reminiscent of a mediaeval tourney; the marquee so bulged with people in the hot morning that some pre-display flying—by a silver Avro 707 and a Hunter, amongst others—was put on to draw some of them away. By afternoon the enclosures and terraces—as seen from the pilot's dispersal, and through the windows of Jock Bryce's Viscount, looking down from a steep turn during a 4½-minute ride—were black with people. Indeed, some 95,000—not nearly so many, however, as there could have been had the week been finer—had come to see all there was to see, and were well rewarded. Not only were the R.A.F. Hunters and Canberras at their best—the former giving a beautiful *encore* between five-twenty-five and ten to six, like maestros proudly showing off their art—but the two F.D.2s flew and (although they could not do their act) produced the week's first official supersonic bangs. Would they be able to do their stuff on Sunday?

Alas for expectations. Sunday morning was so wet that the public "invaded" many private caravan enclosures to shelter, so shrouded in mist that it looked as if there could not be any flying at all. That there was is tribute enough to the pilots, to whom (as always at these wonderful shows) our warm thanks are due. Thanks, too, to all who had any part in organizing and running this 17th S.B.A.C. Display. Had they not been played such a scurvy hand by the weather, this probably—from the public attendance point of view, at least—would have been the most successful Farnborough ever held.

Mr. C. F. Uwins, president of the Society, praised both public and pilots and discounted rumours that the display might be held biennially. "So long as 120 nationalities are represented and the industry's exports go on rising," he said, "we have no reason for making the Show less frequent than at present."

What is needed is that traditional (but elusive) early-September fine weather. Perhaps in 1957 there will be an unlimited cloud-base and the Show will end—thanks to Slade and Twiss—with no whimpers but a bang.

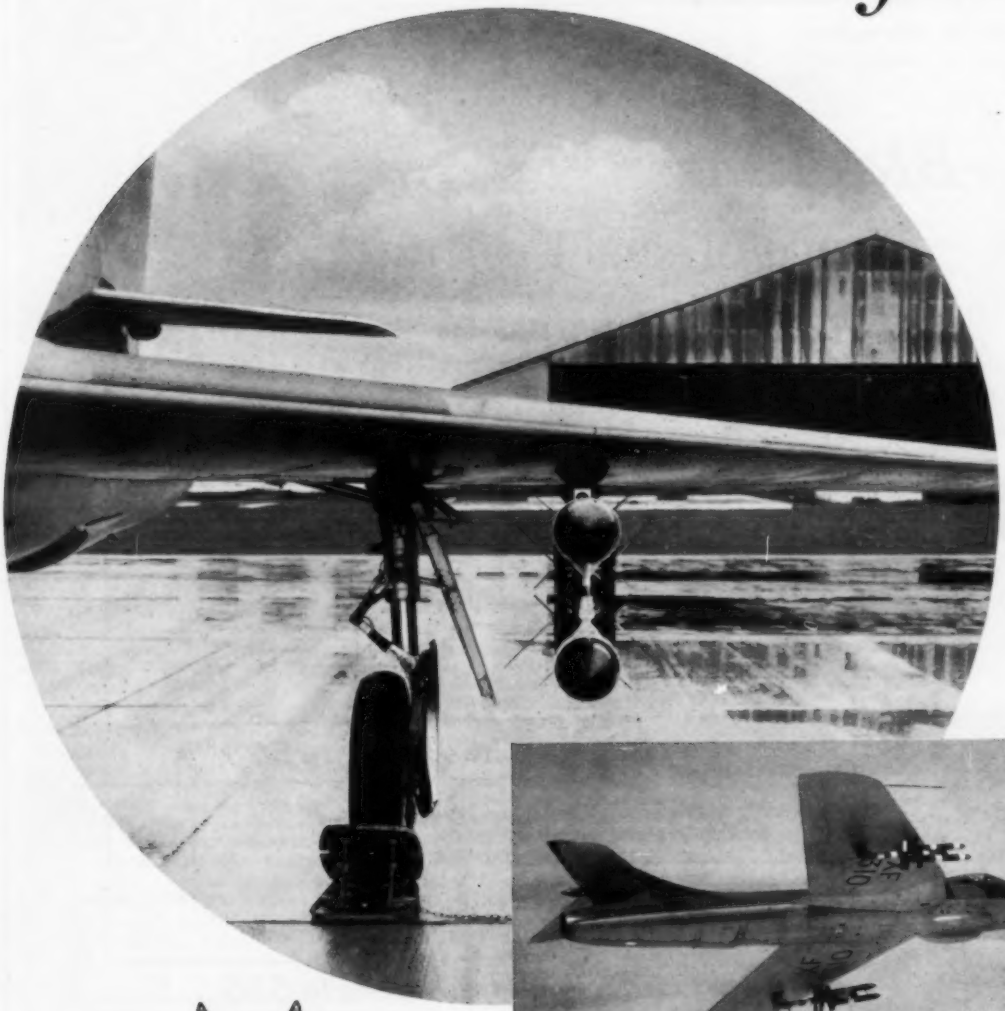
Representing extremes in take-off speed at lower left and lower right respectively are one of the Fairey F.D.2s (actually the speed record holder) and one of a pair of Scottish Aviation Twin Pioneers, bearing the markings of K.L.M.'s Dutch New Guinea associate.

FARNBOROUGH WEEK . . .

(Left) Precursor of gas-turbine-powered military and civil transports is this second-prototype Bristol 173 helicopter, which demonstrated in company with a Sycamore, distantly seen. Coming in below is the first Folland Gnat light fighter for the Ministry of Supply.

On the left, the Gloster Javelin T.3 trainer is manœuvring over the English Electric Canberra P.R.9. Immediately above, the Javelin FAW.7 is landing, and below the Reverse-Thrust Hunter is demonstrating the action of the reverser.

Fireflash



FAIREY

WEAPON DIVISION

Tests now in progress with the Fairey Fireflash, the first British air-to-air guided weapon, are adding still further to the Hawker Hunter's operational versatility. Readily adaptable for either high altitude interception, low level close support or ground attack duties, the Hunter is the standard fighter of the Royal Air Force and NATO Defence Forces.

THE FAIREY AVIATION COMPANY LIMITED · HAYES · MIDDLESEX

The *Blackburn-Turbomeca* range of small gas turbines for the future requirements of the Aircraft Industry

GROUND STARTER TROLLEY . . . **The Palouste 500**

The Palouste 500, producing 2.7 lb./sec. at 56 lb./sq. in. is the ideal air-bleed gas turbine for supplying compressed air for starting the main engines of aircraft. It is incorporated in a trolley complete with all the necessary equipment to render it a fully automatic ground starter unit.

AIRBORNE STARTER POD . . . **The Palouste 500**

The Palouste 500, weighing 200 lb. with a maximum diameter of 18 in., is designed to provide low-pressure air for starting main engines and can be carried in a streamlined nacelle on aircraft bombracks.
At advanced landing fields it is off-loaded and becomes a self-contained mobile ground starter unit complete with wheels, air hoses, etc.

AIRCRAFT AUXILIARY POWER PLANT **The Artouste 610**

The Artouste 610 is a fixed-shaft turbine developing 475 h.p. It is designed to function throughout the operating conditions of modern aircraft and can meet all the necessary auxiliary power requirements, leaving the main engines free for their primary function. Shaft power is available for driving alternators, compressors, pumps, etc., and air can be bled from the engine compressor.

Blackburn and General Aircraft Limited.
ENGINE DIVISION
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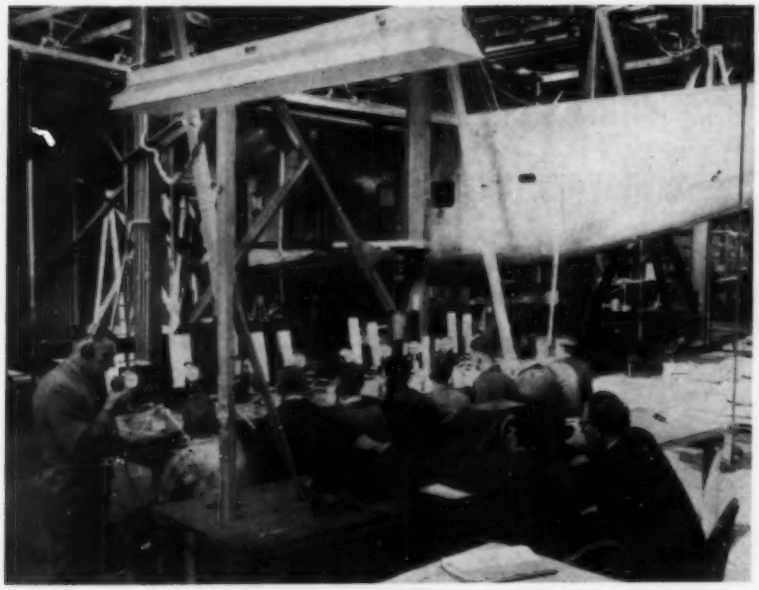


***STILL-AIR GUST:** Nine hands at nine hand-pumps apply a simulated 50ft/sec up-gust to the Scottish Aviation Twin Pioneer, during the final, most critical structural test for airworthiness certification. At 100 per cent of the ultimate load not a single rivet had sheared.*

HERE AND THERE

Carrier Aids

THE U.S. Navy super-carrier *Saratoga* is the tenth American carrier to be equipped with Tacan and with a special long-range U.H.F. radio installation.

Re-orientation

AN excellent example of how values may change under the impact of scientific progress is afforded by the following sober sentence, under *ilmenite*, from the 1911 edition of *Webster's New International Dictionary*: "The presence of titanium prevents it from being valuable as an ore."

Indonesian Albatross Order

FROM Bethpage, New York, comes news that the Grumman Aircraft Engineering Corporation has received a £1,900,000 contract from the Republic of Indonesia for UF-1 Albatross amphibians, to be used by the Indonesian Air Force for rescue and utility work. The contract calls for delivery to start in 16 months.

D.H.C.4 Debut Next Year

THE prototype of the D.H. Canada 4 twin-engined transport, now under development by the de Havilland Aircraft of Canada, Ltd., at Downsview, Toronto, is expected to be completed next year, according to a spokesman for the Canadian Ministry of National Defence. An Ottawa source quotes the troop-carrying capacity of the military version of this aircraft as 20 (plus equipment).

About the Transport Show

OUR associated journal *Motor Transport* is publishing three special numbers in connection with the Commercial Motor Transport Exhibition (September 21-29). These are a pre-exhibition Buyers' Guide (14th); the Show Report (21st) and Show Review (28th). All are price 4d. as usual, and are obtainable either from newsagents or direct from Dorset House, Stamford Street, London, S.E.1.

Model Aircraft Rally

THIS year's All-Britain Model Aircraft Rally is to be held at the Handley Page aerodrome, Radlett, Herts, next Sunday, September 16. The airfield entrance is on the A.5 and public admission is by programme, price 1s, at the gate.

Radio at Farnborough

IN this issue (pages 480-488) a large number of the exhibits in the static show at Farnborough are discussed. Next week we hope to publish a critical appraisal of radio and radar equipment seen at the exhibition.

Mojave Million-pounder

A NEW rocket-test rig being built by the U.S. Air Force in the Mojave desert, California, is designed to withstand up to 1,000,000 lb thrust. It juts from the top of a cliff like an unfinished concrete cantilever bridge, the towers rising ten storeys. Existing test rigs have only been able to take rockets up to 500,000 lb thrust.

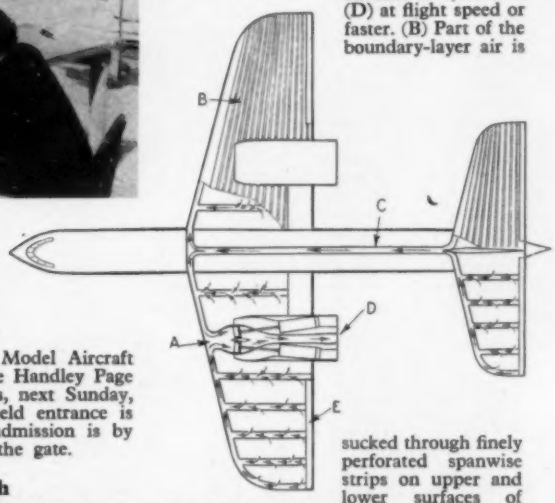
American Records

DURING the American National Aircraft Show, held recently at Will Rogers Field, Oklahoma City, a U.S. Army helicopter remained airborne for 57 hr 45 min. This has been claimed as a new world endurance record. Also at the Show it was announced by the U.S. Navy that Cdr. Robert Windsor, flying a Chance Vought F8U-1 Crusader, had set up a new American air speed "record" of 1,015.428 m.p.h. on August 21. Of the events at Will Rogers Field special photographs will appear in our next issue.

***SIX-GUN:** Operating on the same general principle as the renowned Gatling gun of the last century and having six rotating barrels is Vulcan, seen here delivering 20 mm shells at the rate of about 9,000 a minute. Vulcan is designed for use in supersonic jet aircraft.*

Laminar-flow Installation

THE accompanying diagram has been prepared from a display exhibit shown at Farnborough by Handley Page. It depicts a possible scheme for a future "laminarized" airliner using the system described in our issue of April 13, 1956. (A) Chordwise ducts connect the perforated strips on the wing surface to the main suction duct. This leads to suction pumps which are shaft-driven from the turbojets. Air which has been sucked in through wing and tail surfaces is ejected at (D) at flight speed or faster. (B) Part of the boundary-layer air is



sucked through finely perforated spanwise strips on upper and lower surfaces of the wing; in this way a laminar boundary-layer is maintained. (C) On the tail unit air is sucked through strips on both surfaces of tailplane and fin. Air passes through a duct in the fuselage to the pumps. (E) Small-chord blown flaps are used for control surfaces; they enable laminar flow to be maintained over the maximum area of wing and tail unit.

WELCOMED TO THE SHOW

A Thousand Guests Hear the S.B.A.C. President Explain its Value

ON the Monday of Farnborough week the Society of British Aircraft Constructors once again entertained guests at the annual Flying Display Dinner at the Dorchester Hotel, London. As in past years, it was a truly remarkable gathering of men of all nations concerned with aviation in its various aspects.

Only two speeches were made: after the loyal toast the health of the guests was proposed by Mr. C. F. Uwins, O.B.E., A.F.C., president of the S.B.A.C., and the response was by the Chief of the Air Staff, Air Chief Marshal Sir Dermot Boyle. (In a gathering of more than a thousand guests, some of whom cannot easily hear the speaker and many of whom understand little or no English, it is desirable that the speeches should be brief and not unduly concerned with domestic matters; nor should they be padded with stories appealing only to a British audience.)

Having welcomed the guests to the dinner and to the Farnborough week, Mr. Uwins said that the growing complexity of modern aircraft had in recent years to some extent changed the face of the S.B.A.C. Displays. In the period preceding the last war, aircraft were conceived and built in a relatively short time, and each display saw numbers of new types being demonstrated. Today, prototypes emerged at much longer intervals and inevitably the emphasis had passed to products which, since they were first presented, had been steadily improved and were already giving good service. The Society had, however, decided to continue to hold these displays annually for it was felt that they formed an essential factor in the development of the industry.

"Statistics can be misleading," continued Mr. Uwins, "but we cannot disassociate these exhibitions from the notable expansion of our export trade—from £14¼m in 1946 to £66m in 1955. This year that figure has already been reached and we may expect to pass the £100m mark by a considerable margin before the year ends. The labour force engaged in the manufacture and repair of aircraft and engines, of instruments, special materials, and other equipment which they use, now aggregates some 350,000 men and women."

The president then went on to refer to "the field of technical research and development in which the future strength of an industry such as ours must lie." Saying that in periods of financial stringency it was in danger of being obscured by competing claims yielding promise of more immediate returns, he went on to point out that technical advances were made possible only by constant review of the resources necessary to pursue research. "The equipment necessary for this purpose, whether owned by our members or available in Government Establishments, is under continuous expansion," said Mr. Uwins. "In sheer magnitude it may not be comparable with that of some other countries, but based as it is on careful and far-sighted planning, it will ensure that the British aircraft industry is in the forefront of progress in the constantly expanding fields of aeronautical development. Such fine research facilities as, for example, the new wind tunnels built and operated by the Aircraft Research Association—a body formed by the co-operation of a group of our members—will make their beneficial mark on our products of the future."

After discussing the influence of the introduction of guided missiles and nuclear weapons upon the building of military aircraft the president turned to the subject of civil machines, referring to the success of British manufacturers in breaking into markets on the other side of the Atlantic. The Viscount was established, the Comet 3 had completed a round-the-world flight in recognition of which the pilot, John Cunningham, has been awarded the Harmon Trophy by America; and on its recently completed tour of the U.S. the Britannia had impressed not only by its qualities but by maintaining to the minute a full and difficult programme.

Mr. Uwins continued: "The future of our industry—and here I am looking beyond the next decade—undoubtedly lies in the development of civil aviation, and the traveller of the future will look first to the air to fill his needs. With this in mind our Society views the expanding pattern of world air traffic with satisfaction." And he added: "Not alone do the S.B.A.C. congratulate our State Airlines—B.O.A.C. and B.E.A.—on the splendid progress they have steadily shown over the years, but we welcome also the growth in power and influence of the independent operating companies. The affiliations that have brought some companies into partnership with major shipping lines promise a growth in activity that we all welcome. We are available and anxious to play our part in the expansion still to come."

The president concluded by referring to a number of official guests by name, finally introducing the Chief of the Air Staff as "the largest user of the Society's products, though not the largest purchaser, for that distinction is the due of the Ministry of Supply."

Replying, Air Chief Marshal Sir Dermot Boyle said that the shortage of high-speed wind tunnels could be the greatest handicap to the industry. He mentioned the Britannia's successful "whispering campaign" in the United States and he commented on the fact that Great Britain had now held the world speed record for six months, which was a long time. We had also held the world altitude record since August 29, 1955 [the Olympus Canberra's 65,876ft]. Sir Dermot added that the president, Mr. Uwins, had himself at one time held the world altitude record [43,976ft in the Vickers Vespa in 1932].

After paying a tribute to the work of test pilots the C.A.S. turned to the subject of weapons for the Royal Air Force. He wanted unmanned weapons just as soon as they could do the job better than a manned machine—but the Air Force "will hold on to manned machines for as long as it takes to prove that unmanned ones can replace them." There were some jobs that missiles could never do so well, and for these manned machines would continue to be needed. Sir Dermot added that aircraft manufacturers would find that it was a more expensive task to design and build civil aircraft if there were no military machines to aid them.

SERVICE FOR THE MOTORIST AIR TRAVELLER

WHAT is believed to be the first complete automobile service station at any British airport has been opened at Renfrew, Glasgow. The glass-fronted two-storey building, erected at a cost of £25,000, is designed to be in keeping with the contemporary style of the main airport terminal buildings. Facilities offered for the cars of air travellers are servicing, washing and open or under-cover parking; and there is a car-hire service which can provide a variety of models, self-drive or chauffeur-driven, at very competitive prices. For the travellers themselves there are a lounge, rest rooms and shower facilities, and a new-car showroom for their examination.

The firm responsible, Caledonian Cars (Glasgow), Ltd., have discovered that of the 400,000 people who use Renfrew Airport each year, approximately one-half arrive or depart by car. The new service station is intended to enable an owner to drive up for his air service in the morning, leave his car to be greased, washed or otherwise attended to, and collect it again on his return—all this being done, of course, at a time when he would not be needing the vehicle.

It seems, also, that a larger proportion of people who visit Scotland by air for holidays or business like to hire cars on arrival than is the case at most other air terminals. For this reason a considerable number and range of vehicles is being held available.

The opening ceremony, on August 30, was performed by Sir Patrick Dollan, chairman of the Scottish Council on Civil Aviation.

The new service station at Renfrew Airport, photographed on the occasion of the official opening. Provision is made for air travellers and their car needs in this contemporary-style building, close to the main new terminal.

The Widgeon

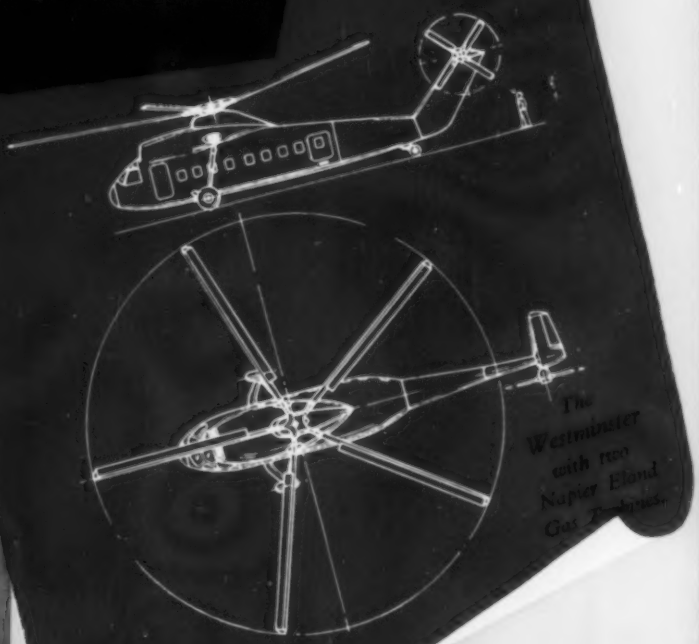
The Whirlwind with Alvis Leonides Major Engine.

WESTLAND

The Hallmark of British

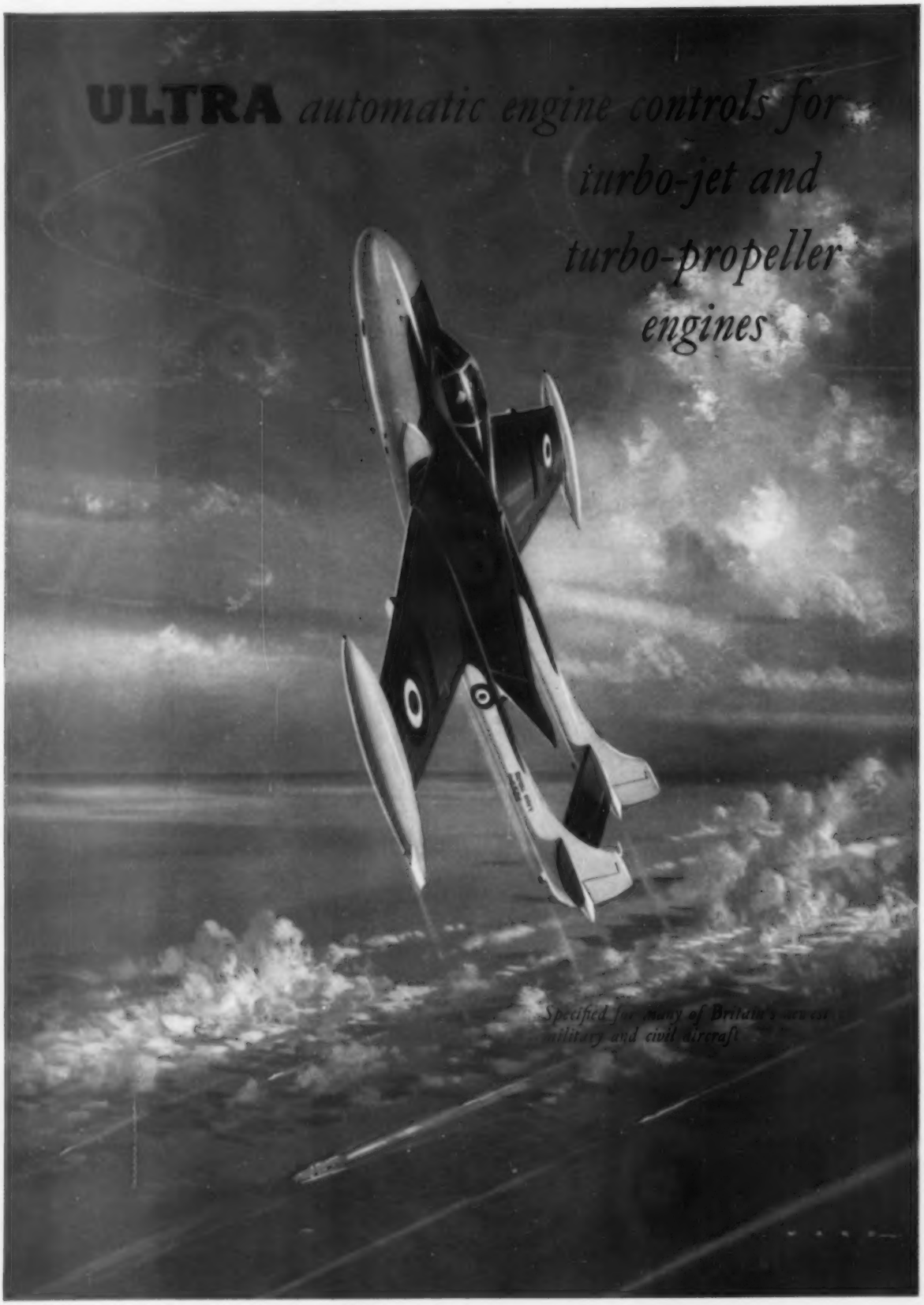
HELICOPTERS

The Wessex with Gazelle Gas Turbines.



The Westminster with two Napier Eland Gas Turbines.

WESTLAND AIRCRAFT LIMITED · YEOVIL · SOMERSET



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THE ROYAL DANISH AIR FORCE
THE ROYAL NETHERLANDS NAVY

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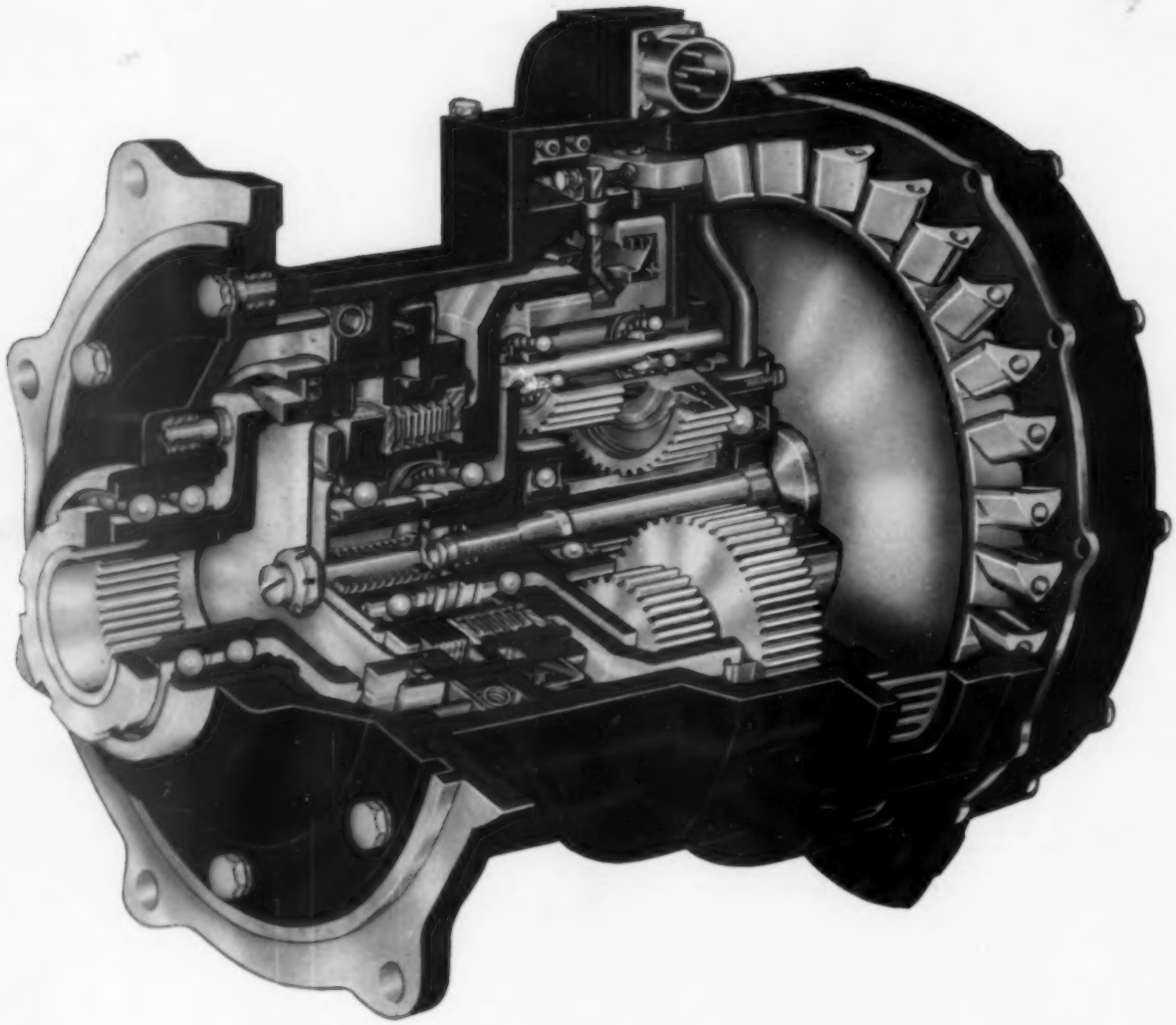

Supremacy in the Air...

Rotax are specialists in the design and manufacture of the finest quality products to meet the reliability standards of the aircraft industry throughout the world. This low pressure air starter has been designed for gas turbine engines with a moment of inertia of 75-80 lb. ft.^{2}; peak horse power is 40 B.H.P. and the time to cut-off is 5½ seconds; pressure across the starter is 250 p.s.i. from 3,000 p.s.i. storage at 15°C.

Design features include: Cold air starting – no harmful exhaust.
Aluminium alloy rotor wheel. Compound planetary gears.
Bullet nose mounting. Grease lubrication.

Characteristic of all Rotax equipment, this starter has a high power to weight ratio, is compact and easily maintained. Our vast experience in this field is at your disposal; Rotax engineers will design any type of starter to meet your particular specification.

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Showpieces

A miscellany of pictures from Farnborough illustrative of aerodynamic design, carrying capacity and detail treatment

Respectively the intended replacements for the Sea Hawk and Sea Venom are the Vickers-Supermarine N.113 (above) and the de Havilland D.H.110, on the right. Optional replacements for Proteus turboprops in Bristol Britannias will be Bristol Orions, the first flight example of which is seen, below, in the port outer nacelle of G-ALBO.

SHOWPIECES

Upper left, root cuffs on the blades of a D.H. airscrew on one of the Scottish Aviation Twin Pioneers. Above, demonstration-load of the Blackburn Beverley. Left the new anhedral tail surfaces on the Vickers-Supermarine N.113 (note also retractable tail bumper). Lower left, auxiliary tanks on the N.113. Below, the Gloster Javelin T.3, showing the revised canopies and laterally mounted periscopes. Bottom left, installation of 3in R.P.s and auxiliary tanks on a Hawker Hunter F.6. Bottom right, tail of the Hunter T.7, showing the revised contour necessitated by the drag-chute stowage above the jet-pipe.

Top left, ranged round this Fairey Gannet A.S.4 are sonobuoys, R.P.s, practice bombs, air/sea-rescue packs, depth charges, sonobuoy dispensers and mines. Upper right, specimen bomb and R.P. loads for the tip-tanked Hunter. Immediately above, installation of 100-gal tanks on a Hunter F.6. Centre right, R.P.s and sonobuoys on the Short Seamew. Below, the new tail surfaces on the Bristol 173. Right, an epitome of power—the intake of one of the D.H. Gyrons in the Sperrin.

SHOWGROUND

Round the Static Exhibits at Farnborough

"Farnborough . . . ." We say it with bated breath; everybody says it and thinks it and talks and looks forward and expects. The word becomes magic, and it means British and best and sometimes new. In eager expectancy we hurry for the first time this year into the great static exhibition tent, thirsting for new gadgets. And as we jostle and stumble we see all that remarkable gear. There are engines and models of aircraft, but we delve further back and find electrical, hydraulic and pneumatic systems, instruments, seats, clothes and research equipment; it is laid out in rigs, rows, piles, racks and cases—and there are cases for carrying it in complete safety through tropical heat and Arctic cold. We march on through lane after lane of stands, through the buzz of technical voices and under the drumming of the rain on the vast canvas roof. We marvel, we congratulate and we retire. . . . Wonderful, wizard, bang on, excellent show . . . .

Outside the "static," with the Martin-Baker ejector-seat trainer rig being demonstrated in the foreground. To the left is Napier's R.J.T.V.29 and beyond are the Decca and Cossor radars and façade of the great marquee.

POWERED CONTROLS

THE past year has seen increasing unification of the efforts of the powered control and electronic equipment manufacturers to produce integrated flying control systems in which the autostabilizer, autopilot, feel simulator and flying control form parts of a common whole. Once the necessity of a "black box" to mix and amplify the various electrical information for transmission to the powered control valve has been accepted, signalling of the pilot's intentions to the surface actuator can also best be done electrically; and other advantages follow in turn—such as the avoidance of feed-back (caused by structural distortion) to the powered control, and the possibility of varying the control-circuit gearing. Three newcomers to the field showed flying controls this year, and further information about some more familiar equipment has been released.

The **Bolton Paul Aircraft** stand was confined to static exhibits and did not include their electrically signalled control system—which, they say, is now nearing the stage for flight trials (with a manual stand-by). Among the exhibits on the stand was a tandem piston-jack with a differential input link to accommodate an autostabilizer. Designed for a medium-heavy fighter, it has duplicated rotary valves which, fed from separate hydraulic pressure sources, pass a maximum flow of slightly under 4 gal/min to the tandem pistons. The valve follow-up is performed by a mechanical link from the output ram and four blow-off valves are incorporated to shed excess pressures into the return line. This same valve block is shown with **Elliott** torque motors attached for electrically-signalled operation, but components of other makes can be used.

The two other flying controls exhibited—the larger of which is fully-sectioned—incorporate the familiar Boulton Paul swashplate-operated variable delivery pump. One of these controls is designed for a bomber with split control surfaces (four hydraulic controls would be required on an elevator) and incorporates an integral D.C. motor, while the other is fully duplicated and may also be operated manually.

A small powered flying control, duplicated hydraulically by tandem pistons and two valves, was shown on the **Electro-Hydraulics** stand. Intended for general rather than specific applications, it has an output load of 8,000 lb and an operating stroke of 4.2 in. A ram rate of 12 in/sec was demonstrated when an equivalent inertia of 336 lb—provided by two bob-weights at the ends of cranked levers—was being accelerated. The two valves are of the spool type and are each supplied from an independent source at a pressure of 3,000 lb/sq in; failure of one source halves the jack operating power. The pressure feed on the demonstration unit was passed through pipes incorporating swivel couplings of Electro-Hydraulics design.

Electrical signalling figured prominently on the **Fairey Aviation** stand, where signalling between a control-column hand-grip and an elevator surface operated by a small piston jack was demonstrated. In the arrangement shown, the jack body was the earthed member. The Fairey rotary-type valve was operated by a **Newmark** torque motor, and an additional miniature control column was used to enable the light operating loads and very small effect of load-relay hysteriais and valve overlap on positional repeatability to be assessed—the elevator surface is fitted with a dial gauge for this purpose. A feature of the system is the use of **Ferranti**-developed A.C. pick-offs at the stick and for feed-back at the elevator.

Incorporated in the circuit is a Fairey-designed feel simulator. The basis of this unit is a coiled leaf spring, the rate of which can be adjusted by re-positioning the pivot to change the effective length. This is accomplished by an actuator which accepts speed or Mach number variations in the form of electrical signals which are pre-supposed to exist within the aircraft in which the flying control and artificial feel unit are installed. Among the other powered flying control equipment shown on the Fairey stand was the Type 779 tandem-piston jack, which has a theoretical output effort of over 44,000 lb at 4,000 lb/sq in operating pressure.

A device manufactured by the recently formed Technical Developments Division of the **Gloster Aircraft Co., Ltd.**, is applied to a feel simulator system, and is designed to modify the feel at a pre-determined Mach number. It consists of two entirely separate but identical units, consisting of one evacuated capsule and one open to pitot pressure, the movements of which are arranged to open a bleed-off valve in the pitot pressure line.

Another electrical signalling system, in this case in triplicated form for "majority-rule" reliability was shown by **H. M. Hobson, Ltd.** In this equipment, the output of a Type 251 tandem-piston jack is controlled by single-stage valves of the sliding-spool type operated by torque motor. A feature of the system is that the electronics which are used to compare the signals from the stick and the position feed-back from the surface may be used to vary the relative gearing between them. The Hobson stand gained much from the large number of working exhibits. Among these was a model aeroplane operated from a control column through a Type 203 piston jack. To demonstrate the effect of autostabilization, the model, which had little natural roll damping, was fitted with a rate gyro from which information was fed *via* an amplifier unit to a Hobson autostabilizer servo actuator Type 214, which was differentially connected to the powered control mechanical input. Autostabilization was switch-controlled for demonstration purposes.

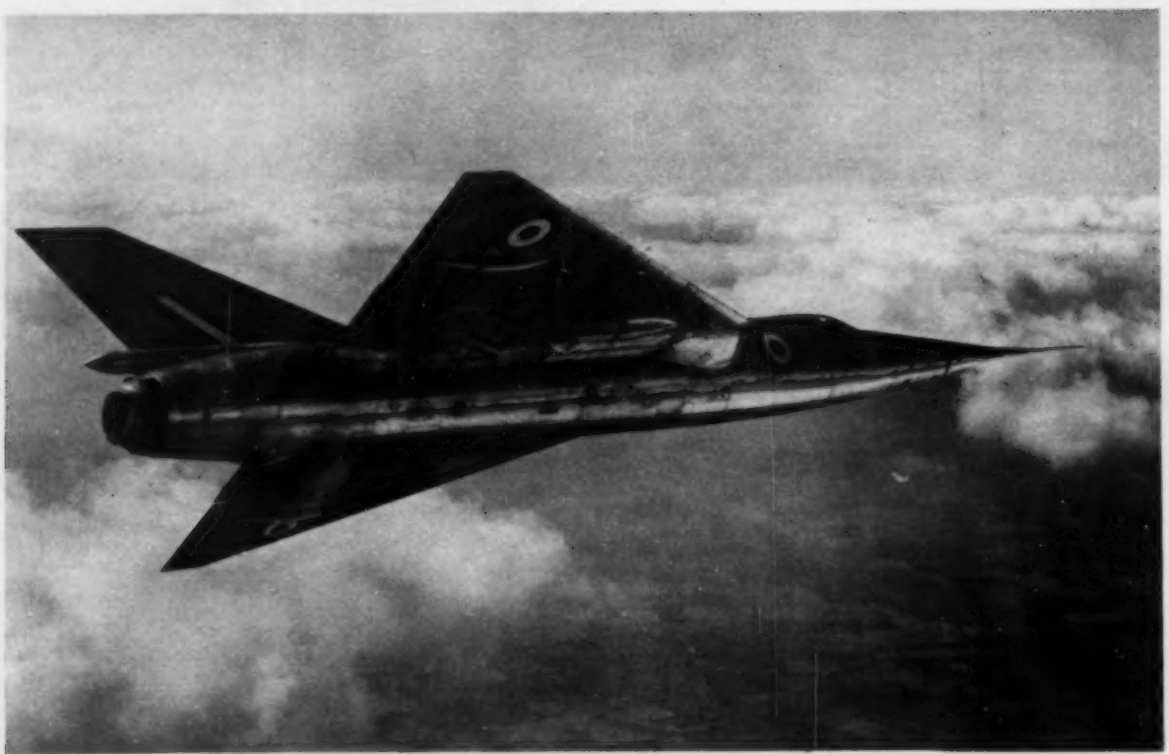
An integrated system which controls the aircraft in both pitch and roll axes (as with elevons) was also displayed. The essential components are two Type 157 double-acting tandem piston jacks with two separate controlling relay valves arranged to operate in unison and two Type 263 autopilot servo actuators which are self-centralizing in the event of electric or hydraulic failure and limited in stroke to reduce the autopilot authority at high speeds in the event of an actuator runaway. In the circuit shown, the actuators and flying controls were paired by links which were coupled to a stick-operated link (for roll actuation) and could be operated in parallel by switch mechanism through a Newmark autopilot.

The remaining working exhibit consisted of a Type 173 Mk 4 screw-jack-type flying control powered by duplicated motors and supply systems—the control is capable of independent operation from one hydraulic system—and a feel simulator control which provides the pilot with "q"-varied stick-rate up to a pre-determined E.A.S. and constant rate thereafter.

The **Lockheed Hydraulic Brake Co., Ltd.**, again showed a wide variety of their

FAIREY DELTA 2

Proved World's Fastest Jet



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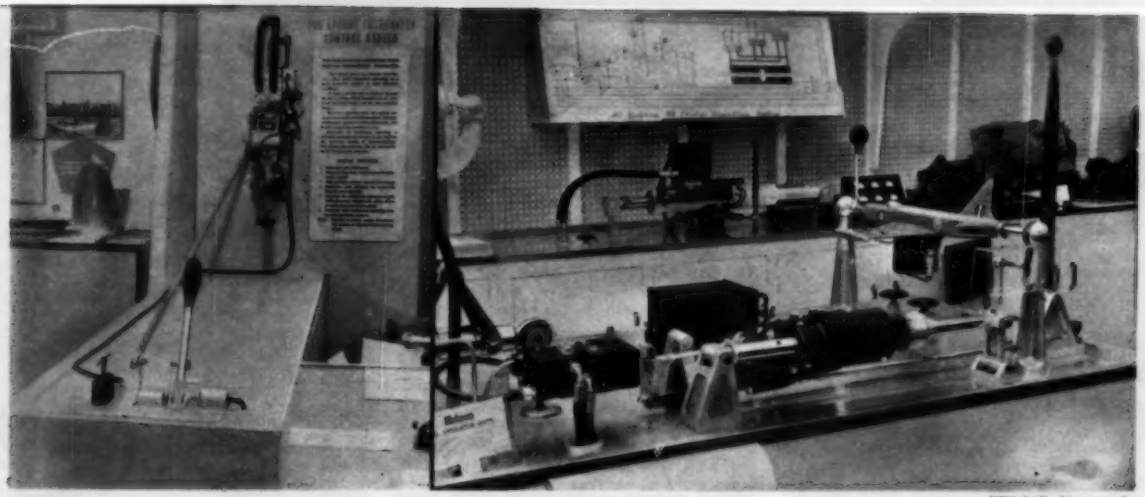
The Vickers Vanguard airliner

(Four Rolls-Royce Tyne turbine engines)

WINGS DAY SEPT. 15th GIVE FOR THOSE WHO GAVE

DE HAVILLAND PROPELLERS



"Flight" photographs

The advantages claimed for the Sperry powered flying control (left) were displayed on an adjacent information panel; roll auto-stabilization of the model aircraft in the Hobson exhibit could be sampled by operating the control column and an auto-stabilizer activating switch.

SHOWGROUND . . .

Servodyne-powered flying controls, which have been developed to a high degree of reliability. One such control, which is used on the Comet 2 and 3 with considerable success, is of the tandem type, weighs 30½ lb and now has a proposed overhaul life of 2,000 hr. In order that the mechanical as well as the hydraulic input can be duplicated, the control intended for the Comet 4 will have a side-by-side duplication arrangement.

One advantage of electrical signalling of the pilot's stick movements to the powered-control valve is that distortion of the structure caused by reaction from the powered control, or distortion of the fuselage under aerodynamic loading, will not affect the position of the mechanical linkage and feed unwanted angle to the control surface. With the mechanical systems in present use, some re-arrangement of the input linkage may be necessary. Special provision of this nature has been made in the powered control exhibited by **Short Bros. and Harland, Ltd.**, which incorporates a banana-shaped link, and is obviously for a specific application. The spool-type valve which is used is completely immersed in hydraulic fluid and is operated through a bell crank and rotary shaft in order to reduce seal friction. This control has been designed for manual reversion, a pressure-loaded plunger operating the "manual-in" clutch if the pressure supply fails.

An example of the modern powered-flying-control thought is shown by the **Sperry Gyroscope Co., Ltd.**, whose new control may be used as a mechanically signalled plain powered control, or, when autopilot integration is desired, signalled electrically from the stick through a Selsyn transmitter. By making both flying control and gyro mechanisms, Sperry are afforded the opportunity of matching response when automatic control is used and reversion to mechanical signalling can be made through a clutch should the electrics or instrumentation fail. Provision is made on the control for a duplicated hydraulic supply with a change-over valve, but other forms of duplication can be provided.

PROTECTIVE CLOTHING

THE whole question of protective clothing for aircrew in case of cabin pressurization failure is evidently reaching a head. For some time now both American and British companies have been working to develop garments along various lines, and two trends were in evidence in the static display—partial pressure and full pressure equipment. Both **G.Q., Ltd.**, and **Frankenstein and Sons, Ltd.**, have made the American type of partial pressure suit, and G.Q. also developed a successful helmet of their own to go with it. Now G.Q. have shown the Type C cloth partial pressure helmet and the Type D which includes a protective plastic shell and gives better visibility, greater comfort and the hole to allow the man to feed himself which now appears to be a standard requirement. Frankenstein showed another approach to this type of clothing. It is based on a Mk 1 pressure jerkin, covering the torso and thighs which will, on selection of emergency oxygen flow, inflate with oxygen and provide compensated pressure breathing and mechanical constriction of the body. Tied in with this jerkin is the anti-g suit Mk 4, which is set to inflate at the same time as the jerkin, so constricting the legs also. The pressure jerkin is equipped with an integral Mae West and Sarah rescue beacon housing, and is intended to be worn as an outside garment. The dummy thus apparelled was surmounted by a partial pressure helmet made by **Baxter, Woodhouse and Taylor, Ltd.**

M.L. Aviation, Ltd., showed three pressure helmets, each of them incorporating a plastic protective shell for the forward and top part of the head. Two of these were of the 11P partial pressure type—the early and developed models. Their vizors were mounted on booms and could be snapped shut by an electric solenoid operated by a pressure capsule, so that helmet pressurization occurred automatically after cabin pressure failure. The newer type had a slightly larger and thicker vizor and both featured red circular trap-doors for feeding and (in less pleasant circumstances) vomiting. The red colour was to indicate that for all normal situations the trap-door should be locked shut. On the later helmet there was no separate intercomm lead "pigtail," and the oxygen tube connector appeared to contain electrical contacts which suggested that the intercomm lead was integral with the oxygen tube. The early version of this helmet was worn this year by W/C. Beamont during very high altitude test flights, together with the pressure jerkin exhibited by Frankenstein. He apparently reported that it was most comfortable. Ranged above the two 11P helmets was the Type F2 full pressure helmet, externally similar to the 11P in appearance, but using a different pressurization principle; it was somewhat larger than the others and bore a cord tackle attached to the flying suit to hold it down on the head when pressurized.

Full pressure suits are more difficult to produce than the partial pressure type because, relying on actual pressurization with air, they present mobility problems. The garment consists basically of a series of large tubes enclosing the body and limbs. Though they freely bend to accommodate a sitting pilot when not pressurized, they have an annoying tendency to straighten inexorably and spreadeagle the hapless pilot when inflated. Frankenstein's own particular solution to this problem was seated in an ejection seat on their stand, but no details of it were being given. The goldfish bowl-type dome over the dummy's head was, in this case, a lash-up for exhibition purposes.

Siebe Gorman and Co., Ltd., admitted participation in the full pressure suit field with a large photograph of a developed version of the full pressure suit which was shown at the Farnborough Jubilee last year. This relies for mobility on linked

A dummy wearing Frankenstein's pressure jerkin and anti-g suit and the Baxter, Woodhouse and Taylor, Ltd., partial-pressure helmet.

Frankenstein's full-pressure suit, at left, was displayed on a Martin-Baker Mk 3 ejector seat. The dome covering the head is representative of, but not identical with, the final head gear.

M.L. Aviation's three pressure helmets (right). The early and latest 11P partial pressure units are at right and left below, and the F2 full pressure helmet above.

"Flight" photographs

SHOWGROUND . . .

pairs of swivelling joints, and seems to give a quite satisfactory degree of mobility. A series of zip fasteners, replacing the armpit-to-shoulder sealed joint, would now appear to allow the suit to be put on far more easily than before.

The problem of the operational advantages of full pressure and partial pressure suits is thorny. In the case of the fighter, it is simple enough to abandon the mission once cabin pressure has failed and the suit inflated, and to return to base. But what must happen in a bomber half-way to a vital and far-distant target? How long can the crew bear either the partial or full pressure suit once they are pressurized? And if the full pressure suit can be adopted for continuous normal use as a miniature pressure cabin, the full-sized pressurized crew compartment might become redundant. If designers take advantage of the fact that a pressure cabin might no longer be needed, the equipment it normally contains would have to stand up to the ambient as opposed to the artificial atmosphere which would then affect it. Incidentally, there seemed to be no face-piece demisting equipment in any of the pressure helmets shown. Be his finger never so long, no pilot could reach into the helmet through the feeding hole and successfully wipe condensation off the inside of his face-piece.

In addition to the airmen's natty suiting referred to above, this group of companies each had a number of other products on view. M.L. presented the drogue gun which they manufacture for de Havillands Super Sprite rocket pack. It is initiated by static line and fires after a delay of 1.5 to 2 seconds. Also there was their 3,000-lb release Type A Mk 1, whose particular advantage is its ability to accept any type of cable loop and to release it over a pulling arc of 120 deg without snagging. This is used in such applications as drogue jettisoning gear of the R.F.D. air-launched target container. The release actuator is electric and duplicated. M.L. have also developed—initially for their own use, but now for commercial sale—a continuity and insulation test unit for electrical circuits which reduces the time required to check a particular circuit from one-and-a-half hours to four minutes. It also tests resistance, capacity and inductance in its bridge comparator. Finally, there was an improved version of the target drone autopilot giving three-axis control, through two gyros, and a height lock, resulting in a new roll- and pitch-command system suitable for control when the drone is out of sight of the "beeper" pilot on the ground.

Frankenstein showed a range of life-saving waistcoats for Army, Air Force and civil use with attachments for **Burndept's** TALBE and **Ultra's** Sarah. G.Q. had on their stand the Mk 4 parasuit with back-type parachute and harness and Mae West incorporated in the suit itself. A barometric parachute release, the Mk 2 full-coverage air-ventilated suit, and the Mk 17 back-type parachute with emergency oxygen supply and barometric release unit completed the G.Q. range of exhibits. Siebe Gorman and Co., Ltd., showed a range of seat belts and protective clothing for fire-fighting; and a special suit for use when handling high-test peroxide.

While G. Q., Ltd., make the parachute equipment for the Folland ejector seat, **Irving Air Chute** supply **Martin-Baker.** On Irving's stand, accordingly, was the new horseshoe-shaped parachute pack for the Martin-Baker Mk 4, lightweight ejector seat. They also exhibited a back-pack parachute for roving members of V-bomber crews. It is equipped with a static line attachment so that, before baling out, the static line could be hooked up at any exit to trigger the barostat rip-cord device as the man left the aircraft.

EJECTOR SEATS

THE state of ejector seat design is now considerably advanced, and the main emphasis this year was on lightweight units. **Martin-Baker** exhibited the latest version of the Mk 4 which is now installed in a score of different aircraft types including the Sea Venom FAW.21 (shown in the aircraft static park), the Vickers N.113, and Hunter T.7; the French Durandal, Taon, Etendard II, IV and VI and the Marcel Dassault M.D.550 Mirage; the Italian Macchi Vampire, Sagittario, Fiat G.82 and G.91; and the Swiss P-16 fighter. Having successfully achieved ejections at ground level, 42,000ft, supersonic speed and underwater with various types of their seats, Martin-Baker have equipped the Mk 4 with the full range of devices which render it fully automatic. Most recent addition is an automatically selected time-delay mechanism which will of its own accord change over from the 1.5 sec ground-level release delay to the 3 sec high-level delay.

The **Folland** lightweight automatic ejector seat has, during the past year, been live-tested and was recently used with great success in emergency by S/L. "Teddy" Tennant. New features this year are more extensive cushioning, shaped to fit the body, and leg-restraining gear with a locking device. There is a face-blind firing control and a secondary firing handle on the seat pan. The parachute is a G.Q. Type 20 lightweight canopy giving a 20ft/sec rate of descent and incorporating in the pack emergency oxygen, a barometric rip-cord and a stabilizer parachute which steadies the man in free fall. Three-quarters of a second after ejection, seat and man are separated and, two seconds later (below 13,000ft), the parachute opens. Tennant's seat had a single cartridge giving a 65/ft sec velocity and he ejected at about 420 kt at 200ft with considerable bank angle. The whole mechanism worked perfectly and Tennant was descending beneath the parachute for ten seconds. The seat's installed weight is 41.5 lb and considerable interest has been shown by companies abroad. A later version, the Type 3, will have a longer stroke gun and an 80ft/sec telescopic gun is also projected.

A new development being tested on a Martin-Baker Mk 3J ejector seat is the **Redwing** gas cartridge automatic harness release which acts on the four root fasteners of Irving Air Chute's combined seat and parachute harness for this equipment. Redwing have also applied the gas-cartridge principle to an automatic parachute release device carried on the harness itself. Manual override facility is provided, and the barometric control unit is set for the present standard height of 13,000ft.

PRESSURIZATION, AIR CONDITIONING AND OXYGEN EQUIPMENT

PRINCIPAL developments in the field of air-conditioning and oxygen equipment were the introduction of Freon vapour-cycle cooling systems and the increasing production of liquid-oxygen converters. **British Oxygen Aro Equipment, Ltd.,** (a new member of the British Oxygen Group) introduced a licence-built range of liquid-oxygen converters together with 50 gallon and 500 gallon vacuum-insulated liquid-oxygen storage tanks. The converter equipment, which is carried in an aircraft as the main oxygen supply, was shown in 5, 8 and 20 litre sizes and in a new 3½ litre fighter installation which weighs 18¼ lb. This latter is equivalent

Left, a Normalair liquid oxygen storage tank and converter, made under Bendix licence.

Right, the Kelvin and Hughes roller blind attitude indicator. This is a significant new departure in flight instrumentation.

in performance to two 70 litre gaseous-oxygen bottles. The advantages in compactness of installation of liquid-oxygen converters are well known. An additional advantage of this range of equipment is that the reservoir itself is made in stainless steel and is therefore lighter and has better characteristics in case of structural damage causing explosion.

Normalair, Ltd., showed liquid-oxygen converters (Bendix licence) for both military and civil application including the military Mk 17 5 litre unit. In this case the reservoir is made of copper and, for safety in case of explosion, is fitted with a steel-cable protective corset.

British Oxygen Aro showed a series of demand regulators including types for normal breathing, pressure breathing and alternative pressure and normal use, each having emergency flow selectors. The Normalair equipment was combined with their standard pressure-demand regulator panel produced under American licence. The lightweight oxygen equipment designed for gliders—and used in the world championships at St. Yan—was also shown by Normalair. Features of an excellent panoramic display on the Normalair stand were a complete aircraft air-conditioning pressurization system (with full complement of heat exchangers, turbines, regulators and water extractors), and a miniature version of this, using the tiny, 10 lb flow turbine (this year no longer a mock-up) which is intended to supply air-ventilated suits with completely temperature- and humidity-controlled air. Another of Normalair's latest ventures is a vapour-cycle cooling system with the necessary fans, compressors and ducting. Normalair are working hard to produce lightweight versions of all their equipment and a number of pressurization and discharge valves in this new category were on view.

Sir George Godfrey and Partners, Ltd., and the **Godfrey Engineering Co., Ltd.,** have also entered the Freon vapour-cycle cooling field, and showed their screw-type compressor pump with an air-turbine drive. Electric drives are also available. They also exhibited a complete ventilated-suit conditioning system and the S.R.M. screw compressor which is specified for the Vickers Vanguard pressurization system.

The Ferranti EV6 gyro vertical with three Type B rate gyros grouped round it. Such a unit would feed attitude information to the roller blind instrument illustrated, above right, as well as to other aircraft systems.

UNDERCARRIAGES, WHEELS, TYRES & BRAKES

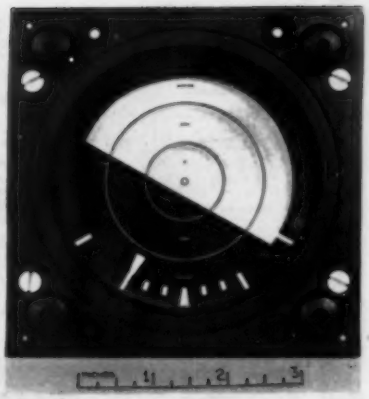
THE oft-stated truism that "the hardest thing about flying is the ground" might be extended to add that components used for the shortest time often work the hardest; this is certainly the case with landing gear, which every year is called upon to provide a little more for a little less. There are developments this year in brake design, tubeless tyres and the special wheels that are needed to go with them, and some detail improvements to undercarriage legs.

British Messier, Ltd., displayed on their stand a very small undercarriage—for the Gnat—and a very large one for the Britannia. The main undercarriage for this machine is of the four-wheeled bogie type, and the nose undercarriage shown on the stand could be steered by an adjacent rocking handle. This handle controls a selector valve which admits pressure to one side of the steering motor. A control arm translates the linear motion of the motor into a rotary motion of the toggle-links (and hence to the wheels) by means of two sleeves which are free to rotate about the outer tube. The follow-up mechanism (which prevents excess rotation being applied) consists of a chain, fitted to the upper end of the two rotating sleeves and engaged by a sprocket attached to the end of a universally jointed rod. This arrangement is actuated by movement of the rotating sleeves.

The main wheel shock absorption is oleo-pneumatic, and a bogie beam at the lower end of the absorption leg carries two pairs of wheels in tandem. A telescopic radius rod mounted forward of each leg locks the undercarriage down by means of a hydraulically applied collet which is released when "up" is selected. Retraction is accomplished firstly by a rotation jack which rotates the bogie about its pivot and then (by sequence-valve command) a retraction jack.

The wheels, tyres and brakes on this undercarriage are all manufactured by the **Dunlop Rubber Co., Ltd.,** who are now manufacturing a brake which is notable for the use of inorganic friction material for the brake pads. In this type of brake, a caliper is formed by the torque plate, spacer tube and back plate. Between these components, steel segments are located radially in rotor spiders keyed-in to the wheel structure, and are brought into contact with the friction pads by means of a pressure plate.

Now coming into service are Dunlop tubeless tyres and special non-porous wheels are being manufactured to contain the air within the tyre and wheel. Both hydraulic and pneumatic operation (using poppet valves) of the Maxaret anti-skid braking controls is now provided, a typical application of the pneumatic unit being in the Fokker Friendship. Over a million Maxaret-assisted landings have now been made, largely by Viscounts in America.



Goodyear Tyre and Rubber Co., Ltd., were showing their tri-metallic brake (a photograph of which appeared in *Flight* of August 31) in which the moving discs are coated with a special sintered iron; and one of the tyres exhibited was of the tubeless type—this, Goodyear expect, will rapidly outplace the conventional tyre which is less satisfactory in accommodating heat-soak from the brake. Special non-porous wheels are being developed.

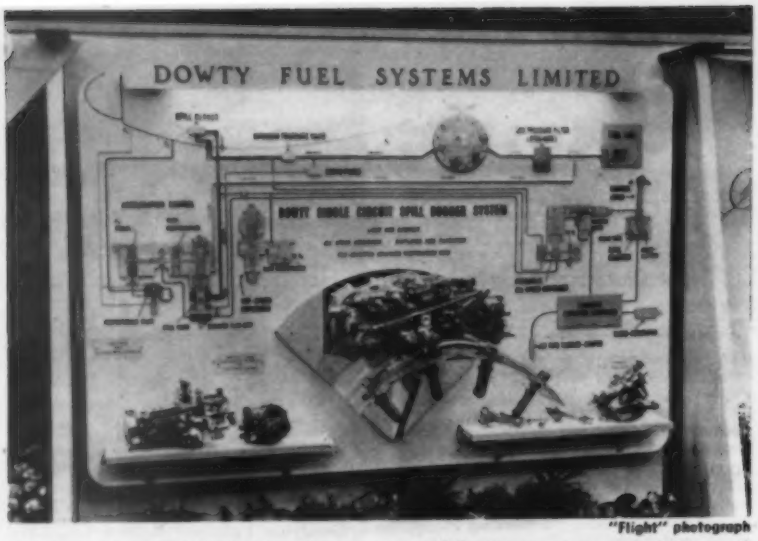
The disc brake which was shown by **Girling, Ltd.,** consists of a disc gripped by friction pads in a caliper set astride single or twin discs floating on axial splines. An independent emergency operating system is provided. A feature of this brake is that the friction-pad wear is taken up by automatic adjustment incorporating the well-known Girling hydrastatic principle. Servicing is simple and can be accomplished with a minimum of dismantling.

ENGINE ACCESSORIES —FUEL SYSTEMS

THE demands of a gas turbine fuel system necessitate specialized equipment to proportion the supply from the fuel tanks, to measure the flow, despatch it along the pipe lines, filter it and finally deliver it to the combustion chambers in the exact quantity required for the particular conditions of r.p.m., altitude and temperature prevailing.

Dowty Fuel Systems, Ltd., have now produced an engine fuel system which is built as a one-piece unit rather than a number of components positioned on the engine at various points and inter-connected by piping. An advantage of this arrangement is that the whole engine fuel system can be serviced from a general access point. This system, which has been designed for use with Dowty spill nozzles, comprises a single basic hydraulic control incorporating an hydraulic all-speed governor. The latter operates over the whole engine speed range, synchronizing electrical trim, temperature maximum limit or range control, acceleration control, automatic minimum safe idling speed control (at all altitudes) and a mechanical governor for emergency maximum speed.

The Dowty spill system gives improved atomization with increasing altitude since, for a given circulatory flow, the quality of atomization tends to improve with reduced rates of discharge from the nozzle. Other advantages claimed for spill nozzles are that the system is less sensitive to dirty fuel because the discharge orifices are relatively large and no valve gear is required



"Flight" photograph

In the one-piece Dowty fuel system the components, although separate, are attached to each other and the unit can be removed from the engine by disconnecting simple trunnion mountings.

SHOWGROUND . . .

in the supply lines to the nozzles. Fine filtration is unnecessary except for the small quantity of fuel required for controlling the servos, which is withdrawn from the circuit and filtered to about six microns. The burner characteristics are such that the fuel pressure remains relatively high in relation to the maximum obtaining at ground level, ensuring constant distribution at extreme altitude and fineness of control to maintain selected engine speeds.

Fuel flowmeters figured prominently at this year's S.B.A.C. show. Among them were two interesting designs by **Elliott Brothers (London), Ltd.**, one of which would indicate flow rates up to 3,000 lb/hr and the other within a range of 420-24,000 lb/hr. The former model, which is particularly suitable for turboprop engines, consists of a transmitter (weighing 3¼ lb) to measure the rate of fuel flow through a metering chamber of the variable-orifice type by deflection of a hinged vane against a calibrated spring—angular deflection of the vane being proportional to fuel flow. The position taken up by the vane is transmitted by a magnetic coupling to a precision potentiometer, and the voltage picked off is fed to the input of an amplifier and thus to the cockpit indicators. As a safety feature, if the pressure drop across the transmitter exceeds a pre-determined figure of 0.5 lb/sq in, a relief valve allows fuel to by-pass the metering chamber.

The second design will measure fuel flow rates for any engine within the operating flow range. In this case, the transmitter, although also of the variable-area type, differs in that the measuring vane moves in a spirally cut chamber against a calibrated spring corresponding to fuel flow rates. The spiral chamber is so proportioned that the first 130 deg of vane rotation gives an indication over an expanded scale from 7-100 lb/min with the remaining range of 100-400 lb/in compressed into the last 48 deg of vane rotation. As before, transmission of the vane's rotation is effected by magnetic means to two Autosyns. One provides a flow-rate signal—directly proportional to vane rotation—to a flow-rate indicator; the other is a linear transformer and is used for obtaining the total flow rate and fuel consumed. These systems provide a continuous indication of the rate at which fuel is being consumed by an aircraft engine at any time, together with the total amount of fuel which has been consumed either by one engine or all the engines in the aircraft.

Fireproof Tanks, Ltd., have now manufactured a tank suitable for H.T.P. fuel. Dissimilar in appearance to the familiar Hycar/nylon tanks made by the company, the new tank is manufactured from P.V.C. sheet, which is high-frequency-welded at the seams and contains no shock-proofing fibres. Expanding metal poppers are used for attachment. This tank has been produced for a specific application, and will shortly be tried in the air. Development of the Hycar tanks has continued in the past year and a stronger rubber mix has enabled the thickness, and therefore the weight of the tank, to be reduced.

A new fuel-flow proportioner was shown by the recently-formed Technical Developments Division of the **Gloster Aircraft Co., Ltd.** Contained within a 9in-by-4in box, this unit is of the mechanical type, the two inlets each containing a diaphragm-operated control valve with a metering disc to operate a control servo mechanism. The proportioning ratio is determined by adjustment of the relative lengths of the metering-disc pivot arms. The maximum fuel throughput is 1,000 gal/hr, and this flow through one inlet results in a pressure loss of 2½ lb/sq in. Should the supply to one of the inlets fail, flow to the engine continues (at an increased pressure loss) from the other inlet against the resistance of a pre-set-maximum control head spring.

A feature of the **Joseph Lucas (Gas Turbine Equipment), Ltd.**, stand this year was a complete Dart turboprop fuel system, consisting of a variable-stroke piston pump, the delivery of which is centrifugal fuel-pressure-servo controlled; a simple flow control to meter the engine fuel requirements by balancing the pressure drop across a throttle valve against barometric pressure; an acceleration control to prevent over-richening by maintaining a constant relationship between fuel and compressor-exit pressures; and a quartz-rod temperature control (working on the differential expansion of steel and quartz) which reduces the fuel flow to prevent continuous operation at the very high temperatures which may occur under cold, high-altitude atmospheric conditions. The particular units on view had successfully completed 1,600 hr continuous operation and were scheduled for another 500 hr before major overhaul.

Seen for the first time was a Lucas electrically-driven boost pump. This is representative of a range of high-speed single-stage centrifugal-impeller pumps driven by submersible A.C. or D.C. motors which can be provided with alternative side or bottom tank mountings. The pumps will run at a designed speed of 5,500 r.p.m. and will deliver from 800 to 2,000 gal/hr. A larger type undergoing development is designed for a flow of 6,500 gal/hr at 12,000 r.p.m. and is to be air-driven by a bleed from the engine compressor. These pumps will operate at fuel temperatures ranging from −45 deg C to +50 deg C at altitudes up to 60,000ft.

Lucas gas-turbine fuel systems are designed for low, moderate or high altitudes, the type of main control used being suited to the operating requirements. In the medium-altitude fuel system for example, a barometric pressure control corrects the amount of fuel according to altitude by limiting the pressure upstream of a throttle valve according to ram pressure. (The pressure relationship is selected according to the pressure/flow characteristics of the rest of the system.) The engine speed is controlled manually by a throttle valve, which varies the pressure/flow relationship downstream of the barometric-pressure control—and consequently the flow as well, since the barometric control maintains a constant pressure at the pump regardless of altitude.

In the high-altitude system, the "proportional flow control" unit incorporates the acceleration control unit, pressurizing valve and dump valves. In this unit, flow metered to the engine is controlled by adjustment of a small by-pass flow according to ram pressure. The by-pass flow is multiplied by the throttle valve and hydraulic flow transformer so that—irrespective of altitude—an approximately constant proportion of the maximum fuel requirement is provided at any fixed throttle angle. By suitable alteration of the multiplication ratio between the controlled by-pass flow and the throttle valve, governor and temperature-overspeed trimming is provided.

Fuel flowmeters of tried design but with detail improvements were exhibited by **Negretti and Zambra, Ltd.** In order to cater for widely differing aviation fuels, a density adjustment for fuels with specific gravities ranging from 0.74 to 0.82 has been added, along with an integrator to give an indication of the total fuel consumed.

Although the effect of bends and elbows on pipe runs is well known it has rarely been as convincingly demonstrated as in the flow model on the **Saunders Valve Co., Ltd.**, stand at Farnborough. The turbulence caused by angles and bends of varying radii were immediately apparent, and the efficiency of various conventional types of valve was placarded. The much used "T" port fuel valve can rarely be more than 70 per cent efficient, a fact

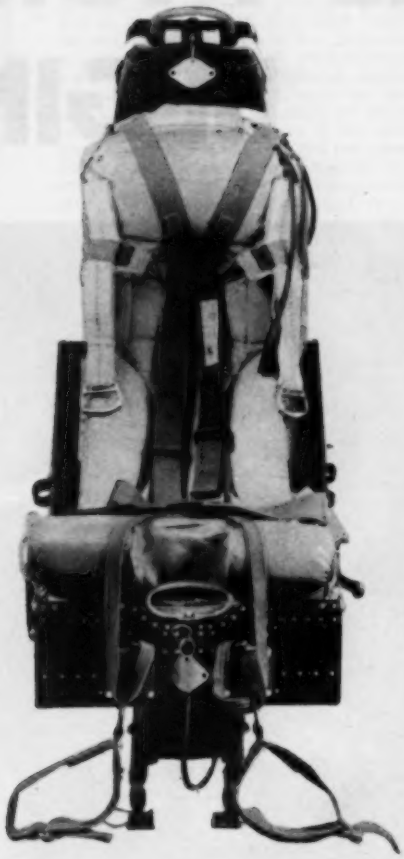
A P.V.C. tank for high-test peroxide fuel has been developed by Fireproof Tanks, Ltd. It is seen here installed for demonstration purposes in a transparent plastic box.

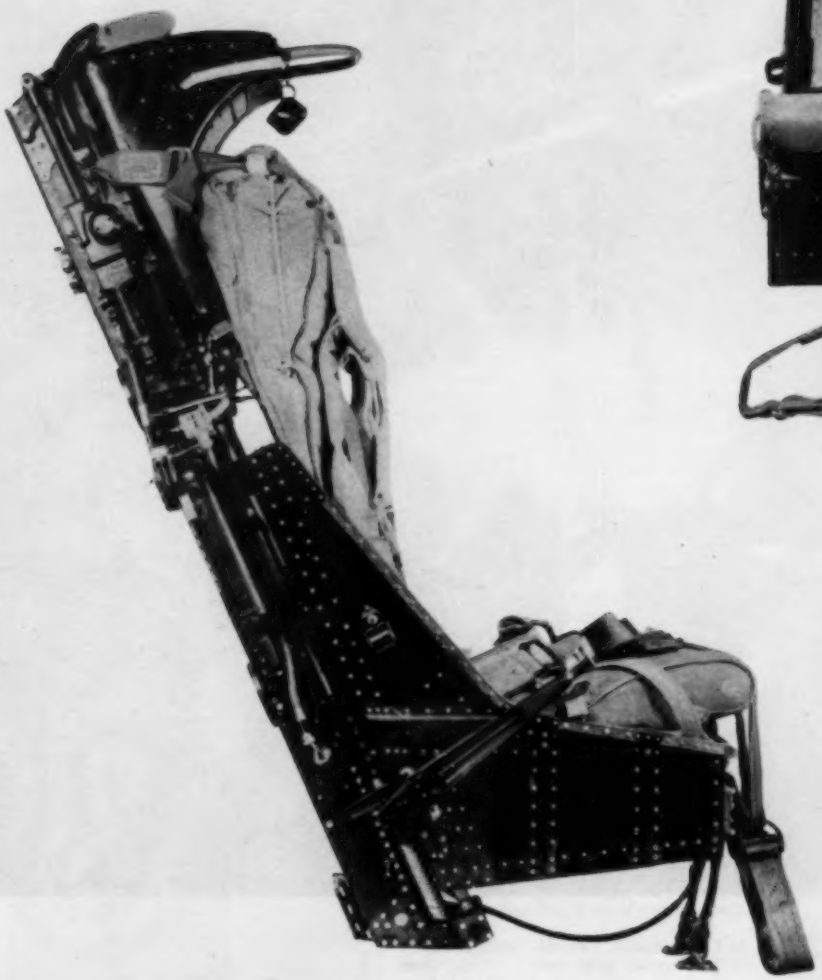
The ejection seat used by air forces of twenty-six nations

The Martin-Baker Patent Fully Automatic Light-weight Ejection Seat, Mark 4, is designed to function efficiently at all operating heights and speeds of which contemporary and projected aircraft are capable. This seat is most compact and weighs only 80 lb. when fitted with the telescopic 85 ft. per second gun. The remarkably low installed weight has been achieved by considerable design ingenuity.

The seat is fitted with the Martin-Baker Patent explosive hood jettison equipment, which enables the occupant to fire himself out of the aircraft with the operation of one control only. When fired, the hood is jettisoned by explosive jacks, followed automatically, a second later, by the ejection seat.

Martin-Baker Ejection Seats have been responsible for saving the lives of many airmen throughout the world.





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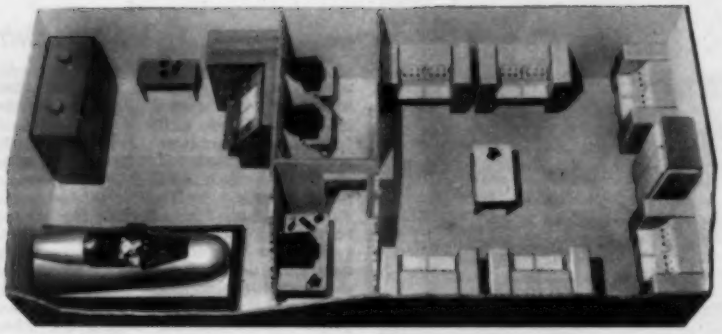


Air Trainers' fighter flight simulator in model form, showing the arrangement of cockpit and computer cabinets in a permanent building.

SHOWGROUND . . .

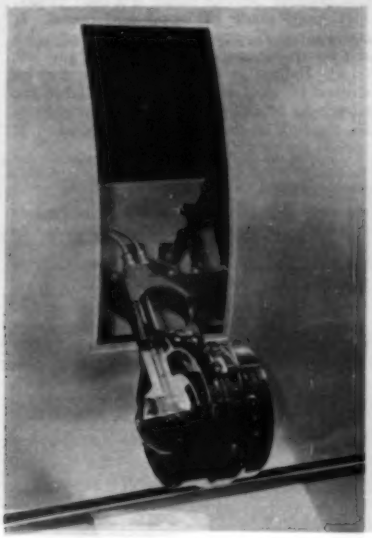
recognized by the company in their new "Y"-port design. The pipe runs to a pentagonal valve of this type can generally be much simpler. Where combining flows are required (two inlets and a common outlet), the "Y"-design efficiency is 90 per cent and the alternative divided flow arrangement is 95-per-cent efficient. As in many other Saunders valve designs, a spherical plug is used which seats on flexibly mounted hard plastic rings which are sealed from the pipeline with an annular diaphragm. The moving spindle and fixed body are flexibly united by another sleeve-diaphragm which prevents leakage to atmosphere; and provided the valve is either fully open or fully closed, the spindle can be withdrawn for inspection or renewal.

A logical development of the electric-actuator-operated range of valves supplied by this company—which frequently have considerably more electrical torque available than the 25 lb/in maximum required—is a series of motorized valves in which the actuator is a specially designed integral part. A marked reduction in size and weight and an increase in simplicity have followed the introduction of this rationalized policy.

ENGINE ACCESSORIES —MISCELLANEOUS

AMONG the very many items of equipment that together with the engine constitute an "installation," recent emphasis has been on controls and valves operated by air bled from the engine compressor. Recognition of this increasing tendency to air-operate has been accounted for in recent compressor design.

A new jack shown by the **Dunlop Rubber Co., Ltd.,** is intended for the operation of engine reverse-thrust controls. It is of the multi-position type and has three controlled stroke lengths. The jack is fed from a constant-pressure compressor-air-bleed supply and stroke position is determined by the particular inlet nozzle in use. The outstanding feature of this jack is its ability to operate at temperatures of up to 350 deg C.



"Flight" photograph

Plessey's flip-out emergency ram air turbine shown in a representative installation. The turbine drives a hydraulic pump and can be extended by mechanical or electrical means.

New enough to be shown only in wooden model form is the **Plessey Co., Ltd.,** low-pressure air starter, which is being made under licence from the American Hamilton Standard Division of United Aircraft. Application visualized by the company for this starter is on three engines of a four-engined aircraft. The first engine to be started (perhaps by a liquid-fuel starter) can then act as a supplier to the air starters, or alternatively, a stored air supply can be used. The starter, which weighs 15 lb, can operate on an air or steam pressure range of 16 lb/sq in gauge to 240 lb/sq in gauge and the upper temperature limit is 300 deg C. In most engines the acceleration time to idling speed with this starter will be less than 12 sec. Incorporated within the starter is an engaging mechanism, compound epicyclic reduction gear and a simple quick-release mounting. A speed-sensitive switch cuts off the air supply at the end of the starting cycle. Failure protection consists of a roller clutch which disengages if electrical failure is experienced, permitting the turbine wheel to run at a steady free speed.

Also featured on the Plessey stand was their liquid-fuel turbine starter which is now in full production for the R.A.F. and other air forces. Made in several sizes, the turbine unit and gearbox are common to all models and the motor—which rotates at a peak speed of 12,000 r.p.m.—consists of a single-stage axial-flow turbine unit driving a reduction gear.

In addition to the starters on this stand, an impressive range of pumps and electrical equipment was displayed. Plessey are also meeting a demand for shutter controls in gas-turbine engine bays with an air-motor-driven ram, capable of moving a load of 5,000 lb through 5in in less than one second with air supplied at 300 deg C. The motor operates on an airflow of 0.4 lb/sec at 150 lb/sq in and responds rapidly to pressure variations. Directional reversal is accomplished in a very short time. Development of this ram is continuing with the addition of poppet valves to regulate the air supply and so provide an infinitely variable output position; further sizes of ram are being considered.

Teddington Aircraft Controls, Ltd., manufacture a very large range of fluid-control valves and switches of all types, many of which are designed for specific installations. Typical of these is a spring-loaded outward relief vent-valve which permits high flow rates at low pressures and is used in fuel tank pressurization installations. Various safeguards against icing-up are incorporated, such as protection of the operating shaft by Fluon bellows and thermal de-icing of the valve seat. Special design is required for valves which must operate at high temperatures, and the Type FKH/A/95 3½in single-way gate valve employs a carbon plate in the sliding gate assembly, which is crankshaft driven from a Teddington electrical actuator Mk 2. Through-put air at temperatures up to 450 deg C can be handled and the actuator mounting has been extended so that the valve will operate continuously at 175 deg C ambient.

A particular problem that has been avoided by the use of Teddington valves (on the Comet and Viscount) is the icing-up of fuel filters and consequent high pressure drops. The solution is to pass controlled hot air over the filters, and for this purpose a pneumatic gate valve (type FMA) incorporating a sliding carbon flow-control gate is manufactured. The operating medium is air (using the pressure in the duct which the valve controls) and the valve is governed by a solenoid.

FLIGHT INSTRUMENTS

A GOOD indication that really interesting and significant progress is being made in the field of flight instruments is that companies are allowed to show no more than one of an intended group of instruments and that little can be said even about that one. However, some indication of present thinking was given by **Kelvin and Hughes, Ltd.,** immediately before the S.B.A.C. Show.

It was then stated that present instruments were considered to be hopelessly out of date for aircraft even of the immediate future. They were too complicated and there were too many separate systems. Basis of the new approach is the use of a single vertical gyro unit to provide information for instruments, autopilot and weapons control systems. Furthermore, Kelvin and Hughes maintained that dials with rotating hands belonged to the "clock age." Linear presentation was required, using the moving tape principle; and the British company claims that, in showing the actual roller-blind horizon at Farnborough this year, it is well ahead of American competitors.

The instrument is basically a remote indicator taking signals from a vertical gyro. The roller blind itself is divided half and half into black and white (white for sky, black for ground). By winding the blind, the horizon can be raised and lowered to indicate dive and climb; roll is shown by tilting the winding unit. Target crosses indicate vertical upward or downward flight, and it is possible to make an accurate roll-off-the-top in cloud using this indicator. The implication, of course, is that it is an instrument which will allow a fighter pilot to make a 180-deg turn in the vertical plane in cloud. The Type 12 gyro vertical which serves the roller-blind attitude indicator is made by **Ferranti, Ltd.**

Kelvin and Hughes also showed the combined Mach-meter and A.S.I. which

"Flight" photograph

The outside static exhibition, seen looking towards the R.A.E.'s balloon sheds.

SHOWGROUND . . .

will, on a single dial, indicate I.A.S. in knots and the equivalent Mach number according to the aircraft's height. Miniature percentage r.p.m. gauges and tachometers, a miniature indicating accelerometer, low- and high-range sensitive altimeter, part of the range of Kelvin and Hughes and Smiths instruments, were all presented on the stand. A particularly useful development is a sensitive altimeter which displays a prominent striped flag at any height below 10,000ft, thus virtually eliminating the possibility of misreading the instrument by 10,000ft during a controlled descent. Another development is the Kelvin and Hughes stall and attitude detector device. Several types of detector are already available, but work is continuing on an angle of attack indicator which will be suitable for use under all conditions, and particularly for assessment of best cruising angle of attack.

The Sperry Gyroscope Company, Ltd., long famous for their work on flight instruments and autopilots, showed the new H.L.9 D.C.-operated artificial horizon and the A.L.30 autopilot. This latter is an advanced version of the well-known A.L.3, and has been specified for the Handley Page Herald, among other aircraft. The H.L.9, being D.C.-operated, is intended to replace air-driven units in aircraft without A.C. systems, or as a stand-by when the main instruments are A.C.-operated. It conforms to the latest performance standards. An interesting exhibit on the Sperry stand was a rig in which a standard production gyroscope was being used to stabilize a mirror which reflected a light beam on to a scale on the wall. While illustrating the stability of the normal Sperry gyroscope, this also recorded the rotation of the earth.

A standard R.A.F. Mk 4A artificial horizon was shown by **Ferranti**, together with the new F.H.7 miniature electric horizon for use with integrated flight systems in modern civil and military aircraft. It has a 3½-in S.A.E. case. Automatic levelling is a feature now offered to facilitate fast erection after starting-up in order to relieve the pilot from using the fast-erection push-button when the gyro has previously run down while indicating more than 10 deg roll or pitch.

Two new exhibits on the Ferranti stand were their Mk 8 gyro gunsight, suitable for use with radar ranging, and the light-fighter gunsight. The latter was designed mainly for the Gnat and features a single sighting graticule and a miniaturized control panel. The Mk 8 sight differs from the older standard R.A.F. gyro sight in having an electric servo-controlled twist-grip ranging facility and a much smaller and neater control panel. Two tiny lights next to the glass sighting screen indicate radar lock-on and minimum range.

AIRCRAFT EQUIPMENT AND ACCESSORIES

IT is remarkable to note the frequency with which wholly new forms of airborne accessory-power make their appearance. In the past few years bleed-air, bleed-and-burn and ram-air-turbine systems have all been developed to supplement the conventional engine-driven systems. In addition, the largest aircraft are sometimes found to employ accessory systems energized by separate power units. An example of such an arrangement is the A.A.P.U. exhibited by **Blackburn and General Aircraft, Ltd.**, in which the source of power is an Artouste single-shaft gas turbine rated at about 450 h.p. at sea level. Teamed with a large alternator, this equipment may go into production for a British bomber.

A possible objection to such a system is that the shaft-power falls off with altitude to an extent which—in aircraft with the altitude ability of the V-bombers—can be considerable. Re-light or starting can also be adversely affected. To provide power independent of altitude **de Havilland Engines** have produced the first units in what will certainly become a very important range of peroxide-turbine accessory drives. Such turbines are already highly developed in rocket-propellant pumps and in the D.H. peroxide starters, and they can provide very high power, low weight and bulk and good reliability; and, of course, as air is not required for combustion, the sea-level output is held to any altitude. H.T.P. is already likely to be present in several future fighters and a few gallons of it is no embarrassment to a bomber.

Lockheed-Hydraulic Brake Company, Ltd., showed a quick-acting, bayonet-type, self-sealing, stainless-steel, hermetically-sealed hydraulic connector. Various sizes between ¼in and 1in are offered and advantages are that high-pressure lines can be disconnected without seepage and that the unit has a long life, is repairable and has a low cost. It is suitable for hydraulic ground-test connections and filler orifices located underneath oil tanks. Another item was a swivel coupling designed for pressures up to 3,000 lb/sq in and having a low torque —6 to 7 lb/in at 1,500 lb/sq in.

Rotax, Ltd., showed a comprehensive selection of their equipment and their latest product, a 15 kVA turbo-alternator. The glass-fibre spherical pressure accumulator, shown last year, has now successfully completed 50,000 pressure cycles at 3,000 lb/sq in.

Joseph Lucas (Gas Turbine Equipment), Ltd., presented a hydraulic transmission using a shaft-driven hydraulic pump driving a hydraulic motor at a remote location. This provides mechanical remote drive without a continuous shaft.

Sangamo Weston, Ltd., have an entirely new icing detector device. It consists of three small components—a detector head, resistance bulb and integral control. Two probes positioned one behind the other relative to the airstream are placed in a location decided by the aerodynamicist. Both probes are heated but the rearward one is effectively shielded by the first. When moisture is present, the condensation on the front probe causes a temperature variation which is not experienced by the rearward probe. This temperature out-of-balance is sensed and interpreted to give warning of icing conditions.

F. G. Miles, Ltd., showed in pictures the chassis of the Viscount 802 simulator they have built for **Redifon, Ltd.**, the Swift F.R.5 and Javelin FAW.4 procedure training cockpits, and the cockpit shell for an **Air Trainers, Ltd**, Hunter simulator. Air Trainers themselves illustrated a model of "a representative fighter flight simulator."

Miles Structural Plastics, Ltd.: Latest project is a 100-gallon phenolic asbestos drop tank, produced in prototype form for the M.o.S., with which they have achieved a 10:1 nesting ratio for compact storage.

The Solartron Electronic Group, Ltd., exhibited a radar-simulator aircraft target control computor console which forms part of their radar simulator. This unit, which is available in various forms, uses actual radar circuits so that it is capable of simulating on the ground not only the standard G.C.I. exercise, but also a variety of radio counter measures and other types of research projects.

Mullard, Ltd., also showed a radar simulator for G.C.I. training in conjunction with a **Metropolitan Vickers** film recorder which could feed into the simulator's P.P.I. display a situation which had actually occurred elsewhere.

Graviner Manufacturing Co., Ltd., had their Fire Wire coiled in rococo patterns on the back wall of their stand, and new devices shown were the Gravinette overheat switch which would operate at temperatures from −70 deg C to +250 deg C with an accuracy of ±1 deg; Crashtrip elements for application to external surfaces; explosion suppression equipment operated by light; and an inertia crash switch for helicopters.

This year **R.F.D. Co., Ltd.**, presented a new air target container designed in conjunction with the R.A.E., Farnborough. Undergoing Service trials is a dart target, 15ft long, made of wood and metal. It consists of a steel backbone fitted with cruciform tapered fins 12ft long and 4ft wide. Ballast in the tubular nose can be shifted to alter the c.g. It is suitable for snatching off the ground or streaming from an aircraft in flight and can be towed at speeds up to 450 kt I.A.S.

THE EQUIPMENT EXHIBITION OUTDOORS

TO the left of the long flight of steps leading up to the indoor exhibition was grouped, out in the open and also within two covered arcades, the heavy hardware.

Dominating all, both by reason of their

importance as well as their need for a clear line-of-sight of the surroundings, were the airfield-surveillance radar units of **Decca Radar, Ltd.**, and **A. C. Cossor, Ltd.** Striped in pilot's-eye-catching orange and white, and with their tireless and vigilant scanners in friendly (but of course rival) 20 r.p.m. phase, these two pieces of equipment provided a forceful reminder of the electronic industry's contribution to everyone's aviation problem—that of congested airspace.

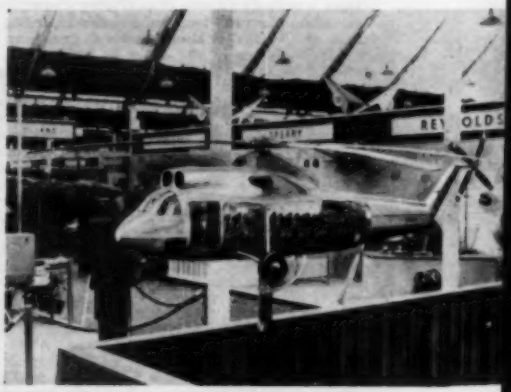
Ekco showed their handy one-man airfield approach aid, which, at the time of our inspection, was receiving the eager appraisal of three U.S.A.F. colonels.

Standard Telephones and Cables, Ltd., also showed their precision approach radar, type SLA.3-B/2. This is meant for permanent installation adjacent to the runway, with presentation in the control tower up to one and a half miles distant.

Although **Marconi** did not exhibit outdoors, it would be unfair to omit here a mention of their ingenious indoor display. They relayed by radio link from London Airport—where, of course, Marconi airfield control radar (type S.232) has been the standard installation since 1952—on to two display units on the stand all the comings-and-goings. Aircraft in the circuit are detected by the S.232 (which works to a 50-cm wavelength, disposing of rain interference without the need for polarization control) on one display; and where "clutter" makes identification difficult, moving target indications (M.T.I.) on the second close-range low-altitude screen conveniently remove fixed echoes. This system's usefulness was vividly demonstrated when M.T.I. was switched off. Most targets just disappeared in the clutter. (The 232 display is, incidentally, provided with references which, when put on to a target, remotely control a separate Marconi height-finding radar). For good measure, Marconi televised aircraft movements, and London Airport's aircraft activities—with commentary—could be watched.

Also displayed here was some of the utility equipment which performs vital if workaday jobs for aviation. One exhibit, new to the show and certain, we feel, to be a best-seller, was the **Laycock (Sheffield)** jet engine maintenance platform. At first glance it had a puzzling "what-on-earth-can-that-be?" look about it, but a process of logical deduction showed it to be, like all good ideas, simplicity itself—a raisable, roomy platform with a hole through which an engine rests endwise on the ground. The engine at the show was an Avon, Rolls-Royce being keen users of this Laycock equipment. **Aero Controls, Ltd.**, showed the infinite usefulness of their slotted structural components most practically, by erecting a lofty stand from which the directors—and customers no doubt—could watch the flying display. **Access Equipment, Ltd.**, with their "erect-in-minutes" components (aptly named Zip-Up) did likewise. **Foamite, Ltd.**, a Tecalemit company, showed their dual-purpose fire-tender, which is fully capable of dowsing fuel fires. **Pyrene, Ltd.**, showed a tender capable of producing no less than 5,000 gal/min of extinguishing foam.

Other exhibits, too numerous to mention in detail, were all worth inspecting. They included **Ferranti's** template-making machine; **Sir George Godfrey's** conditioning and pressure-testing equipment; **E.M.I.'s** vibration testers; **Brockhouse's** and **Zwicky's** mighty runway and apron sweepers; **Brown Brothers'** 50-ton jacks; **A.S.T.'s** equipment for sanitary work, as hygienically designed as could be desired; **Auto Diesel's** and **Westinghouse's** electrical servicing units; **M.L.'s** tubby little radio-controlled target aircraft ready for launching, and their air-freight engine stand with an Olympus installed; **Rubery Owen's** trailers; and **Thompson's** rocket-peroxide fueller. And—stealing the whole show with its periodic detonations—**Martin-Baker's** ejection seat trainer. There was no shortage of ejectees.



Among the most handsome models at Farnborough this year were those of de Havilland Comets, notably that on the left, showing the Series 4A in the markings of Capitol Airlines. On the right is a representation of the Westland Westminster helicopter (two Napier Gazelle) showing, in particular, the seating arrangements of a typical passenger-transport version.

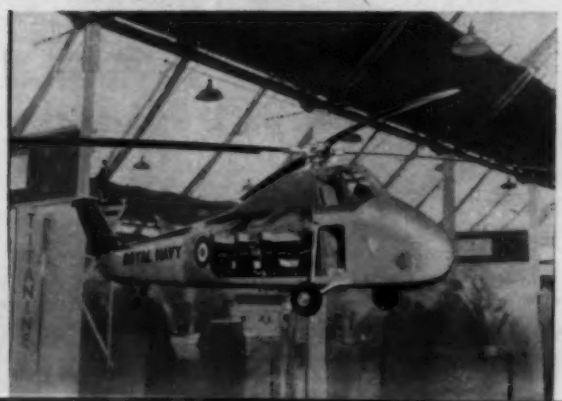
"Flight" photographs

The Future to Scale

On the right, bearing the markings of an unknown State (presumed to be Follandia) is a model Gnat Trainer, also exhibited as a mock-up.

A companion to the model of the Westminster was that of the Westland Wessex, shown below. This was arranged as an "admiral's barge."

At lower right is represented the Hurel-Dubois/Miles H.D.M.106, a descendant of the Aerovan with a high-aspect-ratio wing.



ENGINES AT FARNBOROUGH

MOST of the information pertaining to the new aero engines has already been published in our two preceding issues. The following, therefore, is a round-up of information giving back-references where necessary.

Alvis. Full background information was published in *Flight* on August 31, together with the revised ratings for the Leonides Majors.

Armstrong Siddeley. For the first time the installational mark numbers of engines were quoted. These were the Sapphire 104 (ASSa.12 rating, 8,500 lb, specific 0.91); the Sapphire 202 (ASSa.7 of over 10,500 lb, specific 0.85); the Double Mamba 101 (ASMD.3, 3,035 e.h.p., specific 0.75); and the Viper 102 (ASV.8, 1,750 lb, specific 1.1). On show for the first time was the beautiful display Screamer rocket, fully described on July 27.

Blackburn. Illustrated here is the airborne pack containing a Palouste air-compressor and used for low-pressure pneumatic starting of gas turbines. On another page is a photograph of the Artouste shaft-turbine airborne auxiliary power pack, driving a large alternator.

Bristol. Principal "hot news" is the release of engineering details of the Orion turboprop, which was also flown in the flying display. From front to rear this impressive turboprop comprises: a double-helical reduction gear similar to that of the Proteus (and therefore fully developed) but re-rated at 4,400 s.h.p.; a seven-stage low-pressure (supercharging) compressor, mounted on the shaft driving the reduction gear; an intermediate bearing and wheelcase; a five-stage high-pressure compressor; a cannular combustion chamber with ten flame tubes: a single-stage high-pressure turbine; and a three-stage low-pressure turbine.

Designed to be installationally interchangeable with the Proteus, the Orion is actually capable of providing a smaller and lighter powerplant, notwithstanding the fact that its cruising rating (of, for example, 3,700 e.h.p. at 30,000ft) is almost twice as great and its theoretical sea level maximum power of the order of 8,000 e.h.p. The design pressure ratio of around 10:1, coupled with the design top temperature of 1,000 deg K (1,300 deg F), results in a minimum specific of no more than 0.39—well within the bracket of such engines as the Wright Turbo-Compound. Thus Bristol can make out an almost unanswerable case for such an engine for various transport duties up to at least 500 m.p.h. cruising speed—or perhaps even 600 m.p.h. where no passengers have to be carried (owing to the excessive airscrew noise).

Bristol's other units—the mighty 16,000 lb-thrust Olympus BOl.6, the 4,120 e.h.p. Proteus 755, the 4,000-5,000 lb-thrust Orpheus and the Thor ramjet—have all been previously described.

de Havilland. Possibly the most important engine exhibit at Farnborough this year was the Gyron Junior, a turbojet which has been described as being in the 8,000 to 11,000 lb-thrust class but whose rating cannot be officially confirmed. It was as fully described as circumstances permit in last week's issue.

Its fearsome stable-mate, the Gyron senior, is now known to be giving appreciably more than its initial type-test rating of 15,000 lb—in fact it is about to run at ratings which one might expect would be attainable only with afterburning. This year the display engine was much more "real" in that it was not blanked off but was fitted with a rotating assembly comprising first-stage compressor and rear-stage turbine blades, as well as variable-incidence inlet guide vanes, so that visitors could see all that they could expect to see on a real engine.

Napier. Perhaps the most important of all the company's gas turbines, the trim Gazelle, can now be described in some detail. Designed from the outset for helicopter applications, it can be mounted at any suitable angle and forms a highly compact and efficient unit, with a free-turbine drive—particularly suited to rotary-wing characteristics.

"Flight" photographs

This model illustrates the manner in which the Blackburn Palouste starter pack can be mounted as a store under a high-speed aircraft.

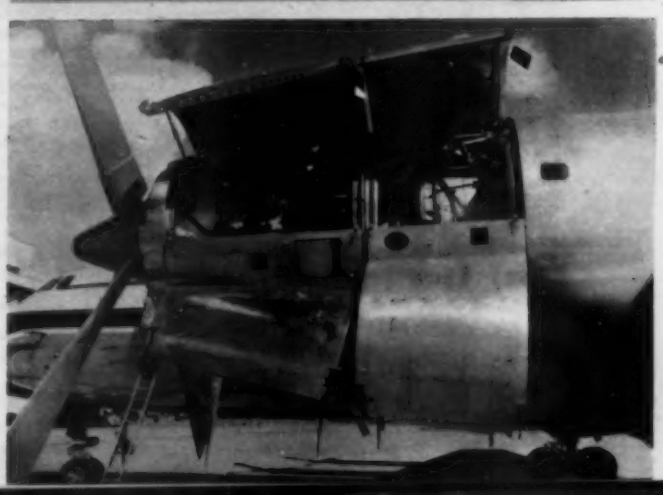
The four principal development stages are the NGa.1 (1,260 s.h.p. and a weight of 780 lb), the NGa.2 (1,650 s.h.p., 830 lb), the NGa.3 (1,800 s.h.p., 865 lb) and the NGa.4 (2,000 s.h.p., 900 lb). The rotating assembly is very like that used in the Oryx gas generating engine, but the combustion system is of the cannular type, with six flame tubes each supplied with fuel from an upstream-injection burner. The exhaust leaves through split pipes on each side of the 6:1 epicyclic reduction gear, incorporating a Napier hydraulic torquemeter.

Other Napier units include the Eland, Oryx and NRE.17 rocket motors, all previously described, and the trim high-test-peroxide rocket booster system flown on the Skeeter 5. The latter comprises a tank mounted above the rotor hub (picture last week) with gravity and centrifugal feed, through restrictors, to catalyst cylinders and rocket outlets at the blade tips (illustrated here). The silver-gauze packs were actually those used by Napier for catalyst development and so the whole programme took only some six weeks to first flight. The smallest N.R.E.19 unit gives 22-25 lb thrust, weighs just over 1 lb and consumes a gallon of H.T.P. per minute; in the Skeeter the peroxide lasts three minutes and puts an additional 66 horse-power into the rotor—sufficient to give many times the original excess power for vertical climb. About 90 minutes' boosted flight has been logged. Incidentally, Napier developed the system without assistance from R.M.I.(U.S.A.) whose "rocket-on-rotor" system is similar.

Another Napier rocket is the powerful Scorpion; installed in the Canberra it had twin barrels with independent control.

Rolls-Royce. The few words here devoted to the company are quite unreflective of the vast programmes going on at Derby; they are merely an indication of how little new information can be published. The only wholly new display engine this year was the beautiful Tyne two-spool turboprop, now rated at 4,695 e.h.p. in "stage 1" form and flown impressively quietly in the Lincoln. The Conway exhibit was almost identical with that seen last year, as was the 200-series Avon; the new RA.29 commercial engine, flown during the week in a Canberra, was described last week, as was the reverse-thrust mechanism fitted to a Hunter 6. All aspects of Rolls-Royce civil-engine development were discussed on August 17.

Napier's Gazelle (left) has a fully automatic control system and can deliver short-time emergency power as much as 30 per cent above its normal maximum rating. The tiny Napier-Saro peroxide rocket (upper right) fitted to the blade tip of a Skeeter. The propulsive jet of superheated steam is clearly audible but not visible. The port outer engine of the Britannia 101 is a Bristol Orion turboprop, shown here with the cowling panels (built as an integral part of the installation) opened fully.



Where there's an airstream... there's emergency power!

The TRA 150/2 Ram Air Turbine provides the answer to a problem which is increasingly concerning the aircraft designer. Here is a unit which will produce the power required to operate essential flying controls under emergency conditions. In such a contingency, the unit illustrated will swing out into the air stream automatically — but it is equally suitable for housing permanently within the airframe, there to be operated by a ducted air supply.

Although this unit is concerned with the production of hydraulic power, it can readily be used to drive an alternator or generator. A version incorporating a de-icing device is also under development.

The Plessey Ram Air Turbine is described and illustrated in Plessey Publication 845. Design Engineers are invited to request a copy.

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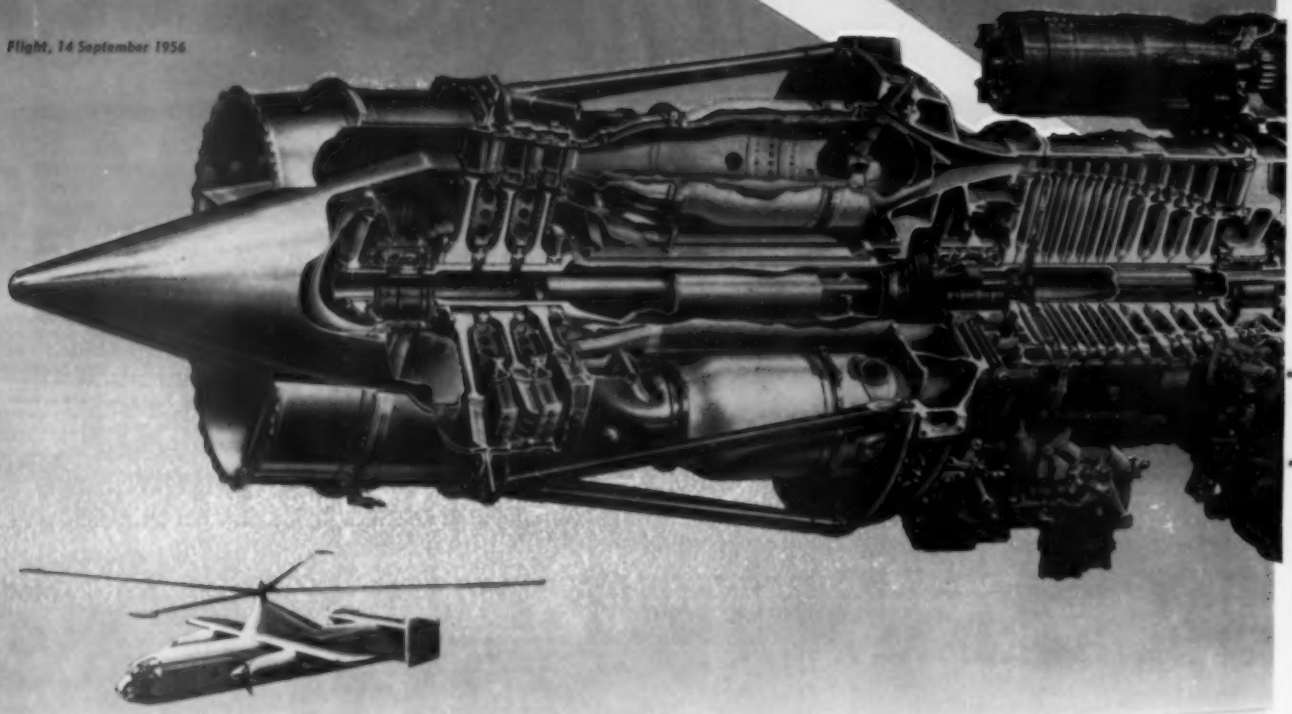


NAPIER *for Air Power*

ELAND. Every medium-haul airline in the world is faced with an urgent decision: how, and how soon, to convert to turbo-props in the 3,000 – 4,000 e.h.p. range. The immediate and simple answer is the ELAND—single-spool, inherently safe and fundamentally economical. The *Napier Eland Convair* is a convincing illustration. It shows (1) the speed and cheapness of ELAND conversion (2) the greatly improved performance figures which result—12,880 lbs maximum payload carried 1,220 miles instead of 290 miles, 50 m.p.h. faster cruising speed—giving a greatly increased profit margin. Faster, smoother, quieter—the ELAND offers medium-haul airliners a new lease of life.

Fairey's new large transport helicopter, the Rotodyne, is to be powered in both vertical and forward flight by two ELANDS—basically similar to the standard ELAND but with an auxiliary compressor mounted co-axially at the rear.

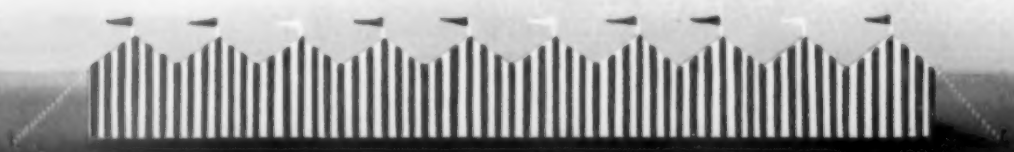
GAZELLE. 1,260 – 2,000 s.h.p. free turbine engine for helicopters—chosen for the Royal Navy Westland "Wessex" and the R.A.F. twin-rotor Bristol 192. For ease of installation it can be mounted in any position between the vertical and horizontal. Helicopters demand tough, reliable engines: the Gazelle is designed for strenuous duty and long service between overhauls, while its outstanding simplicity means economical and speedy maintenance.

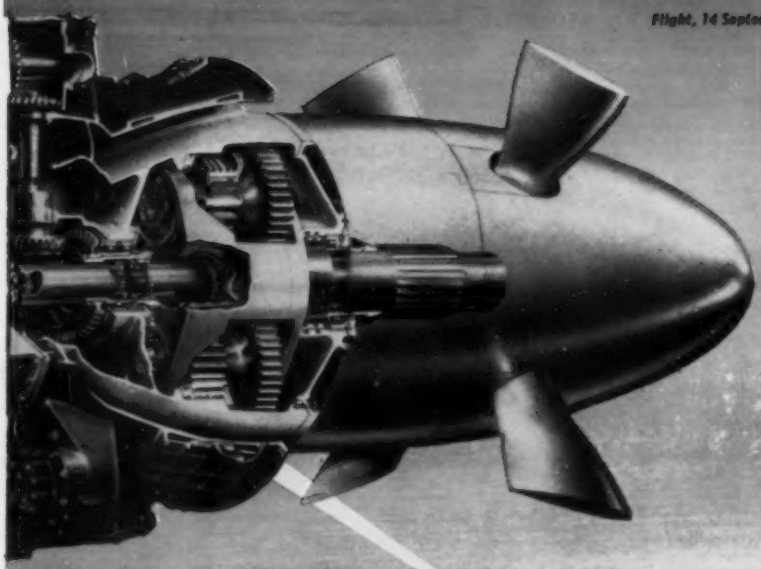
RAMJET & ROCKET ENGINES. At extreme altitudes Napier rocket engines provide the rapid acceleration, increased rate of climb and improved manoeuvrability essential for high-flying interception. Operating on liquid propellents these engines are simple, robust, high performance power units capable of repeated start-stop sequences at any altitude with complete reliability. A Napier-built ramjet test vehicle holds the British height record for such vehicles.

ORYX. The turbo-gas generator for helicopter rotor tip propulsion type tested at 780 g.h.p. and 865 g.h.p.

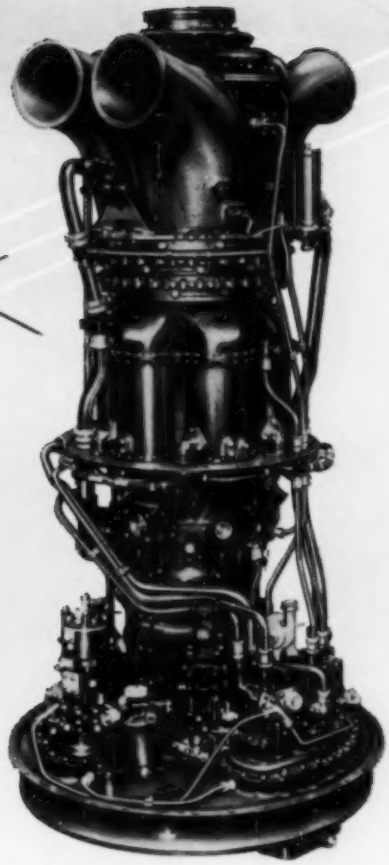
SPRAYMAT electrical de-icing system can be sprayed on to any contour—no matter how complex. To date Spraymat has flown well over 30 million miles in operational service.

D. NAPIER AND SON LIMITED · LONDON, W.3.





Eland turbo-prop



Gazelle free turbine engine

Ramjet & Rocket engines

SEND FOR THIS BROCHURE

"Vibration Measurement and Waveform Analysis"

MUIRHEAD

This publication describes the Muirhead-Pametrada Wave Analyser and how it can be applied to the aircraft, automobile, shipbuilding and electricity supply industries.
Typical applications—noise level measurements, analysis of vibration components, tracing unwanted frequencies to source and checking after final elimination.

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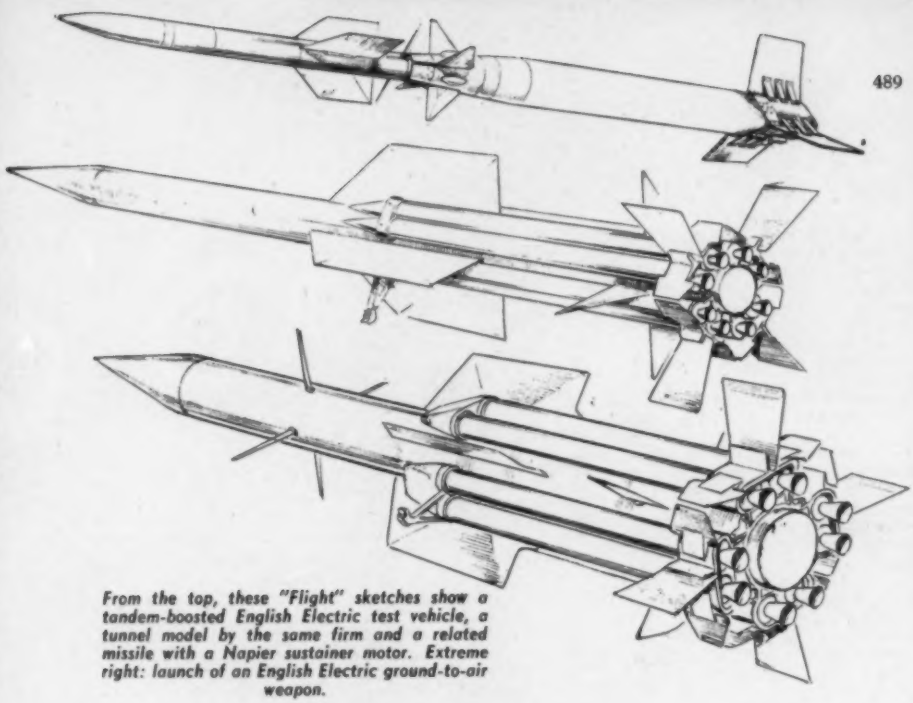
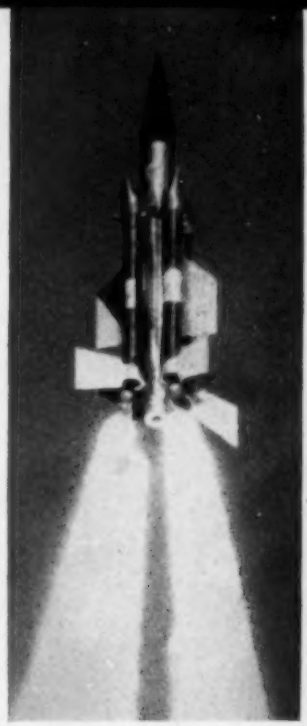




From the top, these "Flight" sketches show a tandem-boosted English Electric test vehicle, a tunnel model by the same firm and a related missile with a Napier sustainer motor. Extreme right: launch of an English Electric ground-to-air weapon.

Missiles at the Show

WITH each succeeding year the number of exhibitors displaying missile equipment at the S.B.A.C. show increases. Although the true size of the missile industry is by no means revealed—since the majority of the firms involved are not members of the S.B.A.C. at all—in previous years it has been customary for the prime contractors responsible for the supply of complete guided weapons to indicate their interest in the field by exhibiting missile-shaped objects ranging from genuine test vehicles to creations completely without significance. Fictitious mock-ups are happily absent this year, except where they are only incidental to a piece of support or test equipment.

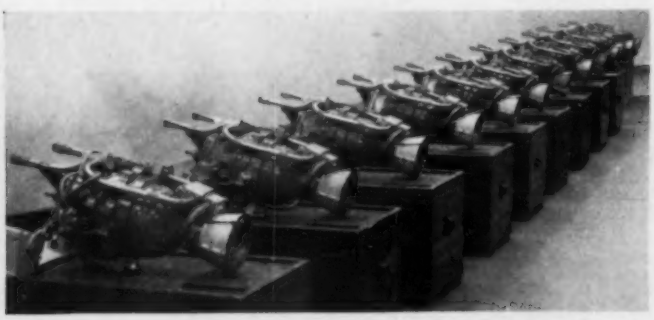
As we stated last week, the principal development during the past twelve months has been the emergence of the air-to-air weapon designed and developed by the Weapon Division of the Fairey Aviation Company at Heston, Middx. Now known as Fireflash, this missile is a beam rider and, after acceleration to maximum speed by the paired booster motors, it coasts for the remainder of its flight. Last week we described the weapon in some detail and published photographs of the method by which it is carried beneath the wings of the Hunter and Swift.

The only other example of a complete missile to be seen at Farnborough is exhibited by the English Electric Company. Embracing as it does the propulsion firm of Napier and the guidance resources of Marconi, the English Electric Group is unique in being able to draw upon all the diverse engineering techniques required to design, develop and mass-produce modern guided weapons. The Group guided weapons division maintains comprehensive research facilities at Luton, development resources in a new factory at Stevenage, Herts, and a strong and well-equipped trials team at Woomera.

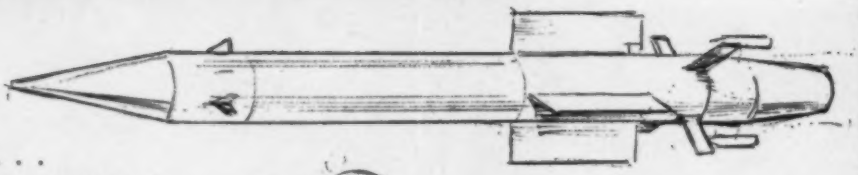
A striking photograph on this page depicts one of the Group's anti-aircraft missiles in boosted flight immediately after launching (not, of course, vertically, as the picture suggests). It is a ground-to-air weapon and is no doubt the missile which was recently announced in the House of Commons as being the subject of a production contract. Our artist has drawn three of the exhibits which are being shown by firms of the Group. The largest is the unpowered dart used as an instrumentation trainer. It is accelerated for ground launching by a tandem booster with triplex motors, the rear of the booster having a triangular cross section with a braced stabilizing fin at each apex. A small, time-fused, explosive charge causes separation and the dart is recovered by parachute. Test data are telemetered through spike aerials.

The wings of this test round were of trapezoidal section (changing to bi-convex at the roots) and similar wings were seen on what was described as "a model used for aerodynamic investigation." This model was clearly manufactured for tunnel tests at relatively low speeds and was roughly one-third full-scale. The booster motors were of the wrap-round type, being arranged in pairs around the after-body in a manner exactly similar to that used on the later Napier ramjet test vehicles. On the adjacent Napier stand was a very similar vehicle described as an English Electric missile powered by a Napier liquid-propellant rocket motor. One of the major "trends" in the missile field is the supplanting of liquid sustainer motors by rockets with solid charges. Contrary to original expectations, the former have been found to present greater problems than the latter. Nevertheless, Napier's liquid-propellant motors are some of the best available anywhere in the world, and it can now be revealed that numbers have been manufactured for various missile programmes. The NRE.11, rated at more than 2,000 lb thrust (a lower-stage rating can also be utilized), is shown in an accompanying photograph. This motor was put into production in 1952 and proved to be small and cheap to make, of high performance and, in the company's words, "truly reliable." Last year the company exhibited the chamber of a later motor, the NRE.17, which has been designed specifically for the propulsion of production guided weapons. Not only is it lighter and more compact than the NRE.11, but the employment of the latest techniques in uncooled chambers and nozzles makes it very suitable for mass production in less than half the man-hours required for its predecessor.

Although not strictly a guided missile, the single-stage, upper-atmosphere research rocket designed by the R.A.E. (Farnborough and Westcott) for the Gassiot Committee programme is well worth a mention. The Ministry of Supply are exhibiting a full-scale specimen, painted black and white, measuring 25ft in length and 17in in diameter. Power is provided by a Raven solid-charge motor, rated at 11,500 lb for 30 seconds, giving a velocity of Mach 5 at 70,000ft and causing the vehicle to coast to an altitude of approximately 100 miles. Payload varies from 100 to 150 lb, the weight at launching being roughly 2,560 lb. The



Production Napier NRE.11 motors awaiting shipment to Woomera.



MISSILES AT THE SHOW . . .

launching is effected from a tower which can be pivoted to compensate for the prevailing wind. The vehicle will telemeter data and will later be developed to bring back permanent records. Initial firings should take place at Woomera late this year.

A particularly interesting stand in the static show was occupied jointly by Bristol Aircraft (G.W. Department), Bristol Aero Engines and Ferranti. Two specimens of early test vehicles were shown, with transparent skinning to reveal the disposition of the interior mechanisms. The principle function of these vehicles was to assist in the development of control systems, and one was equipped for parachute recovery. The later vehicle, which is illustrated by our artist, was launched by triplex tandem boosters to a maximum velocity of over 2,000ft/sec, reached in 2 seconds with a peak acceleration of 35 g.

Bristol ramjets were also well to the fore on this stand, and, as well as a complete display Thor BT.1 engine (No. 1208), the air-driven fuel pump and hydraulic pump for a ramjet-powered vehicle were displayed for the first time. Both units had light-alloy cast bodies and employed single-stage axial turbines fed from ram-air intakes. The fuel pump had a single centrifugal impeller, whereas the hydraulic power unit employed a compact design of pump in the centre of the body delivering fluid at high pressure to actuate the control surfaces. As the sketch shows, the intakes were bifurcated, and governing was integral, the r.p.m. being controlled by butterfly valves in the air exits.

A number of missile components were displayed by English Electric, one of the most noteworthy being a power pack energized by a single-stage axial turbine fed with gas from twin slow-burning cordite charges. The chief accessory mounted on the pack was a three-phase alternator. Another array of missile accessories was to be seen at the Dunlop stand, and a new item here was a self-regulating source of compressed air. The storage capacity was provided by a solid forged light-alloy bottle, in the base of which was mounted a combined solenoid-controlled starting and reducing valve. Owing to the fact that all g.w. components must be absolutely reliable and must start to function the instant they are needed, the valve is of a very high-duty type, subjected to oscilloscope tests to ensure that it immediately settles down to deliver at the correct working pressure. The combined unit is in production.

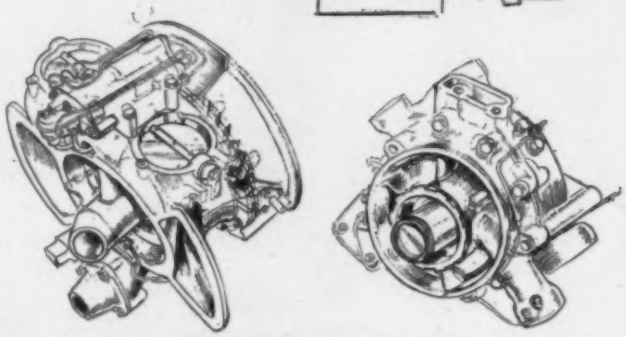
This characteristic of absolute reliability and sure starting is also coupled with the requirement that a missile should "come to life" before it is fired. As a part of a system for supplying electricity and air to a ground-launched missile, Sir George Godfrey and Partners have developed under government contract a connecting arrangement which enables cooling air, electrical power and signals to be delivered to a missile prior to launching. In brief, the Missile Electrical and Air Connector, or M.E.A.C., is supported on a guide rail which carries a conductor rail and an air supply and is coupled up to the missile. Immediately after the firing circuit is energized the M.E.A.C. automatically separates from the missile.

As its name implies, the conductor rail is "live" and is insulated to carry electrical power which is picked up by the M.E.A.C. through spring loaded brushes. Cooling air is delivered through a valve to a pipe at the rear end of the unit.

The M.E.A.C. consists of a carriage, a telescopic tubular strut and a shoe. The carriage serves as the base of the unit and is carried by two sets of rollers. One of the telescopic struts is pivoted about the underside of the carriage; at the other end is the shoe, on a spherical joint. When in use the strut is locked in the extended position, but a release mechanism is provided to allow the arm to retract, then swing forward and upward after the missile has been fired.

The firing signal circuits are led through contacts on the M.E.A.C. carriage which engage with contact pins mounted in a fixed electrical contact box. The M.E.A.C. is coupled to the missile through an electrical and air socket mounted in the missile. It is located by dowels and held in position by spring loading in the strut. Air and electrical power are delivered, through the strut, to the socket which has silver-tipped contact pads for the electrical supply and a central inlet port for the cooling air.

An exhibit by the G.W. division of Elliott Brothers (London), Ltd., was a radar receiver occupying no more than 170 cu in overall. Such compactness has been allowed by printed circuitry, not only on individually replaceable parts but in the circuit board connections at the rear of the sockets—demonstrating that dip or auto soldering can be applied, in mass production, to such points, virtually eliminating all wired joints. Five of the main units were made with all components on one side of a copper-clad board, the etched circuit—including gold-plated etched plugs—being arranged on the reverse side to permit dip soldering. There was much evidence of careful engineering to give long and trouble-free service. One of the circuit boards was exhibited on the stand of Bakelite, Ltd.



An early Bristol rocket-boosted dart (top) used for control tests. Left and right are the hydraulic power pack and fuel pump used in a Bristol ramjet-powered test vehicle.

Another miniaturized display was the set of tiny silver-zinc accumulators by Venner, who are world leaders in this field. SZ6/12. The latter is a 10-cell unit rated at 60 amp-min on a Designed to M.o.S. requirements were the widely used SZ6 and 3-amp load, the output potential being 12 V. Yet another example of beautiful miniaturized electronic work was the telemetering pack developed by E.M.I. Electronics, Ltd., and displayed by them in company with a Fireflash airframe. Such equipment would not, of course, be installed in a production round.

A second aspect of Bristol's missile work concerns the production of rocket-motor casings. We were encouraged to see the manner in which their Banwell (Weston) factory has gone into production with motors in which the case is fabricated from sheet, with precise Argon-arc butt-welds using tungsten electrodes. At present the case for the Raven is the biggest production job, measuring 17in by 16ft 10in. The sheet is a chrome-molybdenum steel (75 tons u.t.s. minimum) of 0.104in nominal thickness. Heat-treatment takes place after assembly.

Several Bristol motor cases were on view in materials for which B.S. and similar specifications have yet to be written. One had a light-alloy tube lined with Durestos, a material used to make another complete chamber with glass-fibre wrappings to increase the bursting strength. On the stand shared with Ferranti already referred to, the company showed a Mayfly booster nozzle forged in light alloy with integral attachments, and—like other modern motors—employing a nozzle lined with RA.51 Durestos. Mayfly was described on June 15 last.

Other Raven cases are built up from lengths of drawn steel tube. This is a speciality of the Chesterfield Tube Co., who can now cold-draw any steel (minimum of about 10 s.w.g.) from 6in to 24in bore. With hot finishing they can handle considerably greater thicknesses up to 35in bore, or around 30in for stainless. Their Raven motor case uses 0.104in material—like Bristol's—but is made of carbon steel drawn out to about 10ft.

E.M.I. Electronics, already referred to, used an RTV-1 test vehicle to demonstrate their very efficient EMV.5 electro-magnetic vibrator, which we expect to describe in a future issue. In its stripped form the RTV-1 weighed some 300 lb and the low input of 5 kW could impart a peak thrust of 3,000 lb (i.e., 10 g). These vibrators are being used by the M.o.S., Fairey and other missile firms.

One of the items displayed on the G.E.C. stand was a dish-type radar "employed in the development of guided missiles." It appeared to be a conventional tracking unit capable of being mounted in the nose of a launching aircraft or used in a ground installation, but the company were not empowered to comment on the exhibit. The RTV engineers of Marston Excelsior were responsible for the control compartment of a rocket booster test vehicle complete with electronic packs. Yet another exhibit with missile applications was a carrying container for production weapons exhibited by Hairlok. This comprised a steel drum roughly 6ft by 30in with a particularly neat self-sealing cap.

Most of the Ministry stand at Farnborough was devoted to non-warlike equipment, but nobody could fail to be impressed by the chamber for a liquid-oxygen and kerosine motor placarded as "over 50,000 lb thrust." Although this is only of the same order as the V-2 chamber of a dozen years ago the techniques are incomparably more advanced. The chamber jacket had 32 identical consituent parts each forming a tubular axial passage for regenerative kerosine cooling. Each segment was formed from side-by-side strips machine-welded and hydro-pressed. Combustion pressure was stated to be approximately 500 lb.

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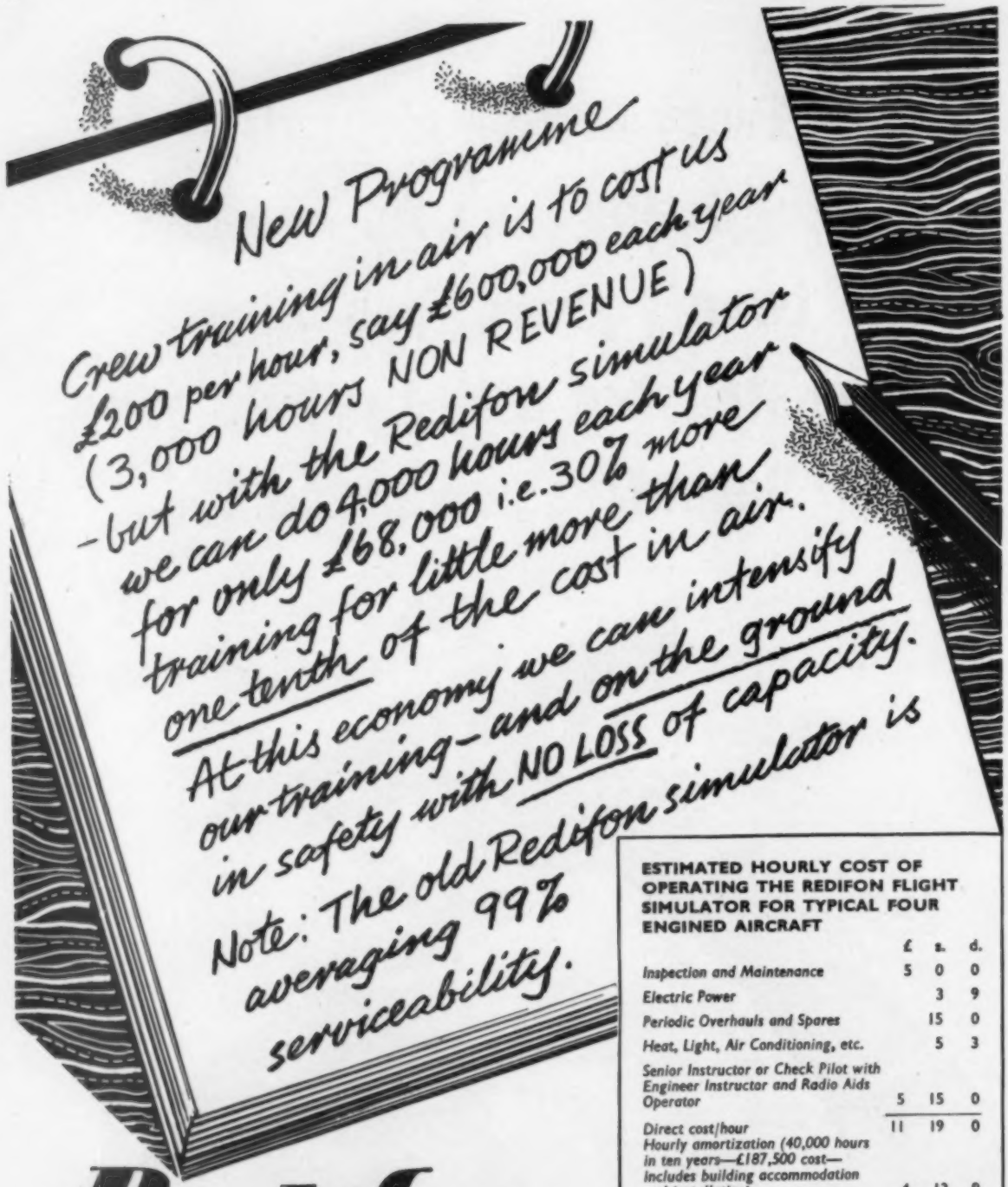

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LOCKHEED C-130A HERCULES

A Big Military Transport of Exceptional Versatility

IT is now some time since preliminary notes on the Lockheed C-130A Hercules were published in *Flight* (August 13 and December 10, 1954) and since then new information has become available, enabling the cutaway sketch overleaf to be prepared. Lockheed's big transport utilizes some novel constructional and mechanical features aimed at fulfilling the many difficult requirements of airborne assault in one "logistic" aircraft, and its success in this respect is likely to appeal to civilian operators as well.

The Hercules was conceived to meet a specification issued to several aircraft companies early in 1951 by the U.S.A.F. Tactical Air Command. The requirements called for an aircraft which would meet the growing need for a vehicle capable of transporting substantial quantities of freight or personnel with a high degree of operational flexibility. Typical military applications which were borne in mind in the early design were the aerial delivery of heavy equipment—trucks, bulldozers and artillery—to forward areas secured by dropping paratroops. The necessity of operation from ill-prepared airstrips (on far-from-ideal soils) and the evacuation of casualties on the return trip were further considerations which required special features in the design and prevented any bias in favour of pure load-carrying capacity. Long range, satisfactory performance with one engine inoperative, and a cargo floor at a height suitable for loading from vehicles represented a further challenge to the designers. By the middle of 1951 Lockheed (Georgia Division) received contract authorization to develop a prototype.

These features are obviously just as valuable to the civilian operator as they are in the military sphere, and it is estimated that the direct operating cost (in commercial operation) would be about 4.0 cents per ton-mile, compared with 6.0 cents per ton-mile for the military version.

The resultant aircraft has not proved to be wildly unconventional, but rather a sound design of relative simplicity, embodying many well-considered features. The relatively high aspect ratio of 10, and the use of four turboprops, were dictated by the necessity for long range and adequate performance and economy at high altitude. The somewhat unusual undercarriage arrangements have been designed to cater for soft-field tyre flotation characteristics, demanding large low-pressure tyres. Lockheed claim that excessive structural weight resulting from undercarriage retraction requirements has been avoided. The fuselage shape is near to the ideal for loading and carrying bulky cargoes of varied shapes.

Structure. A number of new processes and materials have been utilized in the construction of the Hercules airframe. Among these, the limited use of bonding—in such applications as the joining of doublers and stiffeners to the trailing edges of the wing and tail unit—enabled lighter gauges of aluminium to be used in about 100 assemblies. This method of attachment has, however, been limited to flat panels to reduce production problems while shop-handling techniques were being evolved.

A new high-strength aluminium alloy, A785-T, is used extensively throughout the aircraft, particularly in plate form and for primary-structure extrusions. About 210 individual parts are fashioned from this material, a number of which weigh over 100 lb apiece. This probably represents the greatest use of A785-T in any aircraft being built at the present time. Quite remarkable are the wing skins. Both the upper and lower surfaces of the primary wing structure are machined from plate stock to leave integral stiffeners; the largest panel is 48ft long and is tapered along its length. An extension of the same technique is used for the cargo floor, which is made from a series of integrally stiffened extrusions and integrally machined parts.

About 140 components, notably the nose and main landing gear assemblies, latches and hinges for the large pressure doors and special bolts, are fabricated from steel, which is heat treated to give 120-125 tons/sq in ultimate. Steel 4340 has been found to give the best combination of mechanical properties, and special care in heat treatment is required, as practices which are acceptable for lower-strength steels become unacceptable where 4340 is involved. The engine nacelles and flap skins must make use of commercially-pure titanium sheet. The 300 lb of titanium used on the aircraft represent a 25 per cent weight saving over the alternative use of stainless steel. [*contd. overleaf*]

An impressive study of an impressive aircraft, this photograph shows one the earlier Hercules, with unmodified nose section.

LOCKHEED C-130A HERCULES . . .

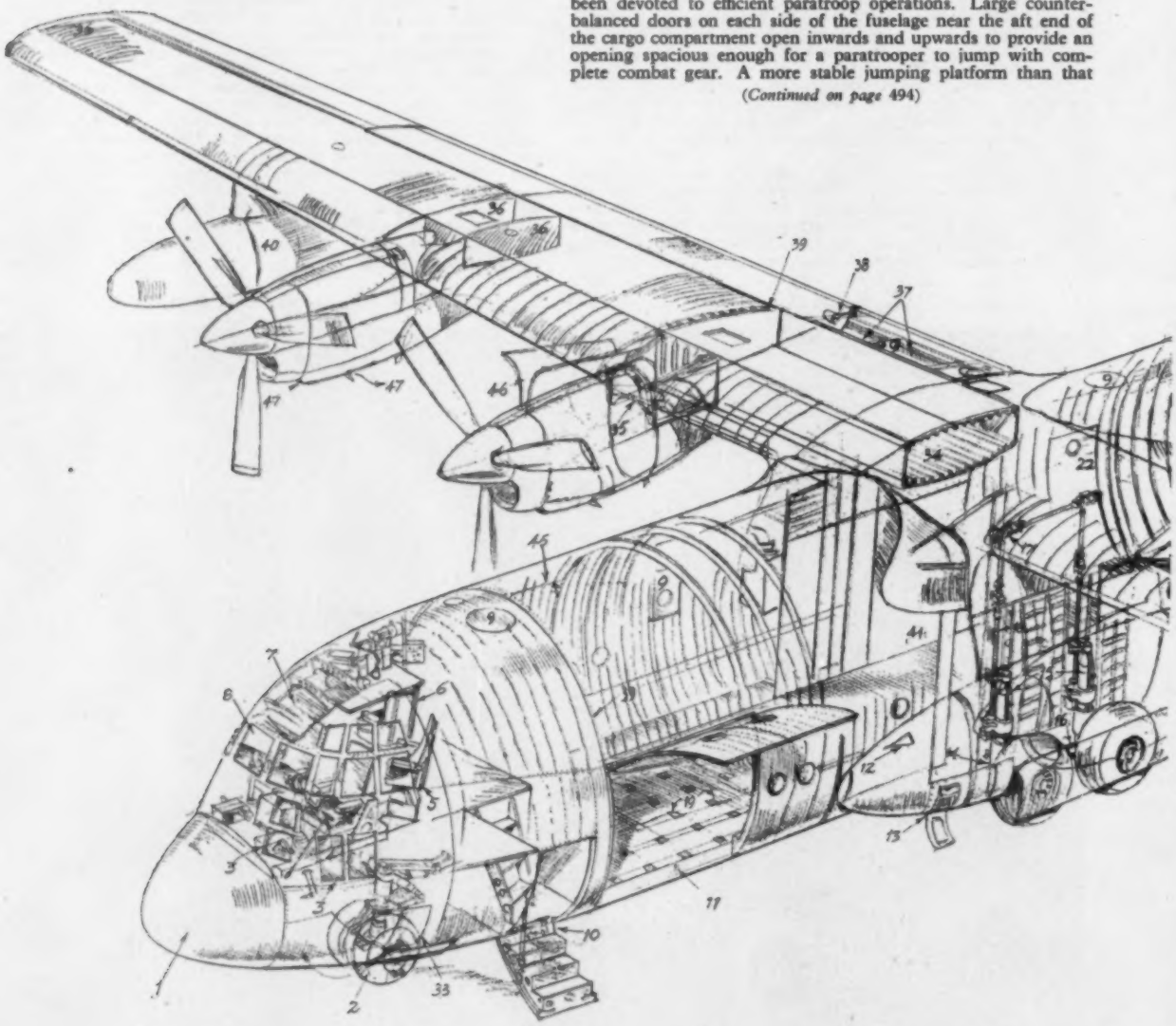
At the outset of every new design, the designer makes considerable effort to provide a high degree of interchangeability of parts, and, if he can, to make all the equipment as accessible (*via* panels and doors or hatches) as possible. As conflicting demands accumulate, only stern refusal to compromise these features will avoid their sacrifices to the insistent demands of space and mechanical expediency. The C-130A has been fortunate in this respect. The powerplant nacelles, elevators, main landing gear and paratroop door assemblies, pylons and many access doors are all interchangeable. Furthermore, a large number of access panels have been provided to allow for the maintenance, repair and inspection of various components with the minimum interference from crew members or cargo loaders.

Fuselage. Designed to accommodate a useful cargo volume of 4,300 cu ft including the space over the cargo door, the fuselage contains a cargo compartment 41.5ft long, over 9ft high and 10.3ft wide at floor level. A measure of this capacity is the volume of 3,680 cu ft available when loading to a height of 100in with 18in aisles on each side of the cargo space. Some 3,850 cu ft of volume are available where stowed equipment is to be air-dropped. Access to the cargo compartment is *via* a hydraulically-operated forward cargo door 7ft 3in wide and 6ft high, and by two very large doors beneath the rear fuselage. These doors, which are operated by multiple hydraulic jacks, can be controlled either from the flight deck or from a valve beside the door. In the fully extended position, the lower half of the door functions as an integral ramp from the cargo compartment to the ground, and, by means of detachable bridge plates, loading can be accomplished from truck-beds of varying height. The rear half of the door hinges upwards into the rear fuselage, the contour of which is such that access to the 10ft by 9ft stowage area is not restricted by the door sills or operating mechanism. Cargo loading has been the subject of considerable research by Lockheed, who have studied the size, weight and loading methods of typical packages used in particular applications. The conclusions they draw are that military payloads—which are usually of a fairly dense nature—could generally be accommodated in a fairly small cargo section, although in fact the Hercules operates efficiently when carrying bulky cargoes. The ramp cargo loading door is also a great help where mechanized or fork-lift loading from dock or ground level is required.

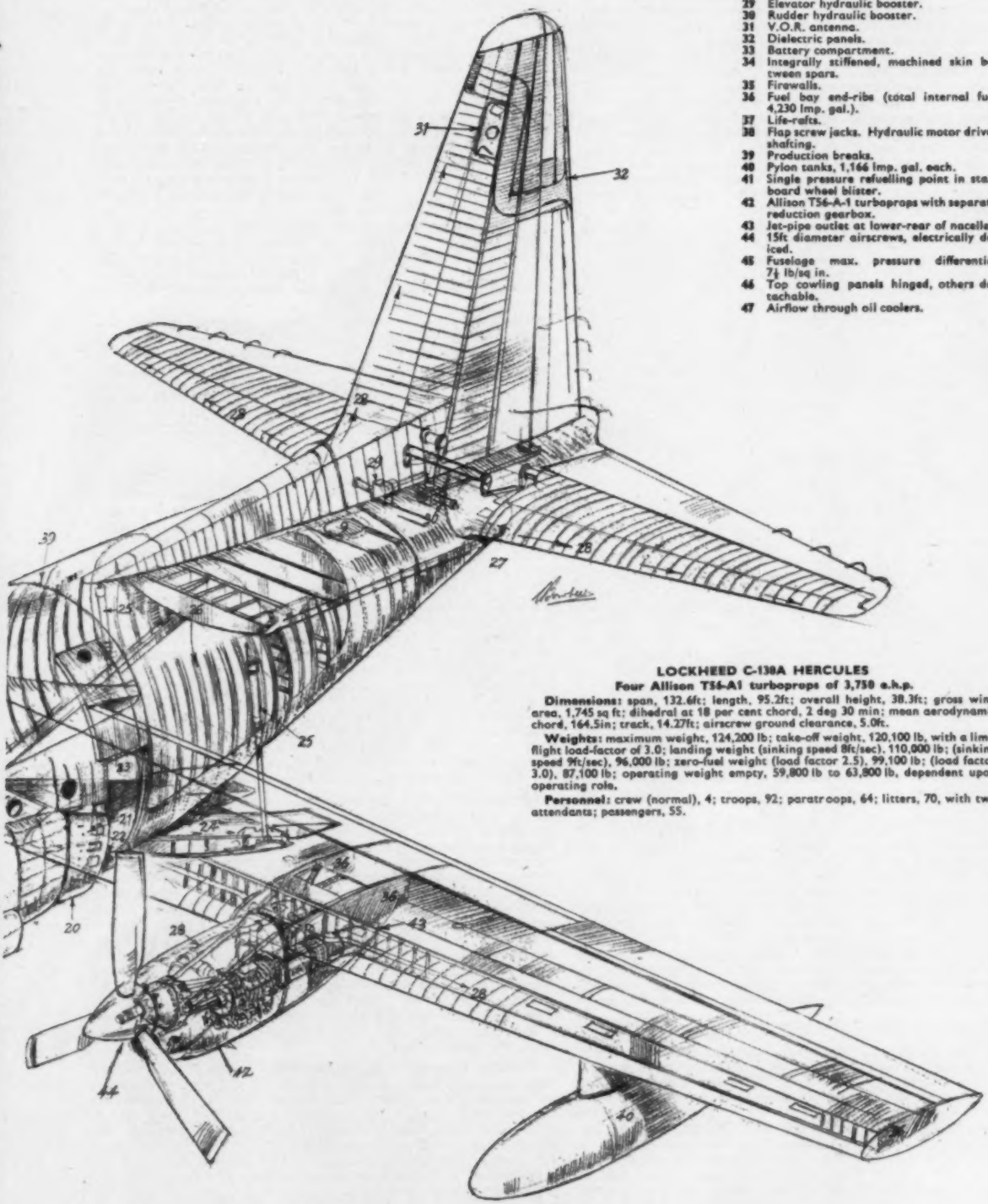
Once the load is inside the fuselage, the ground time is reduced by the numerous tethering fittings. On the fuselage floor a high-density (20in) grid pattern is formed by 10,000-lb fittings, while many additional 5,000-lb tethers are provided on the fuselage walls and on the loading ramp. Additionally, a lesser number of 25,000-lb fittings are provided for unusually heavy cargoes, and snatch blocks (one fixed and one demountable) aid the loading of wheeled vehicles or other large items at weights up to 25,000 lb. An additional advantage bestowed by the configuration of the aircraft is that, thanks to the high wing and tail, ground trucks and loaders can move around the cargo bay unhindered.

Conversion for carrying troops can be made quickly; the troop seats are normally stowed in the aircraft. Much thought has been devoted to efficient paratroop operations. Large counter-balanced doors on each side of the fuselage near the aft end of the cargo compartment open inwards and upwards to provide an opening spacious enough for a paratrooper to jump with complete combat gear. A more stable jumping platform than that

(*Continued on page* 494)



1 Radar AN/APN 59.
2 Forward-retracting twin nosewheels.
3 Extra forward/downward windows.
4 Nosewheel steering-wheel.
5 Flight engineer behind pilot and co-pilot.
6 Navigator.
7 Overhead switch groups (air conditioning, fuel, fire emergency, and engine control panels).
8 Nesa glass windscreens with two wipers.
9 Escape hatches.
10 Crew entry, and stairs to flight-deck.
11 Forward freight door, 7ft 3in x 6ft 0in.
12 Intake to 13.
13 Auxiliary gas-turbine compressor (engine starting air, emergency hydraulic pump, D.C. generator).
14 SCR-718c radio-altimeter antennae.
15 Vertically retracting main undercarriage.
16 Fore-and-aft member.
17 Hydraulic motor driving 18.
18 Screw-shafting.
19 10,000 lb cargo tie-down points (5,000 lb and 25,000 lb points at sides).
20 Windstream deflector, paratroop protection.
21 Jato bottle mountings, four each side.
22 Paratroop door with floor extension.
23 Counterbalanced paratroop-doors.
24 Integral loading ramp.
25 Jacks for 24.
26 After-belly door hydraulically-raised for loading.
27 Hinge point of 26.
28 Hot-air ice elimination.
29 Elevator hydraulic booster.
30 Rudder hydraulic booster.
31 V.O.R. antenna.
32 Dielectric panels.
33 Battery compartment.
34 Integrally stiffened, machined skin between spars.
35 Firewalls.
36 Fuel bay end-ribs (total internal fuel 4,230 Imp. gal.).
37 Life-rafts.
38 Flap screw jacks. Hydraulic motor drives shafting.
39 Production breaks.
40 Pylon tanks, 1,166 Imp. gal. each.
41 Single pressure refuelling point in starboard wheel blister.
42 Allison T56-A-1 turboprops with separate reduction gearbox.
43 Jet-pipe outlet at lower-rear of nacelle.
44 15ft diameter airscrews, electrically deiced.
45 Fuselage max. pressure differential 7¼ lb/sq in.
46 Top cowling panels hinged, others detachable.
47 Airflow through oil coolers.



LOCKHEED C-130A HERCULES

Four Allison T56-A1 turboprops of 3,750 e.h.p.

Dimensions: span, 132.6ft; length, 95.2ft; overall height, 38.3ft; gross wing area, 1,745 sq ft; dihedral at 1B per cent chord, 2 deg 30 min; mean aerodynamic chord, 164.5in; track, 14.27ft; airscrew ground clearance, 5.0ft.

Weights: maximum weight, 124,200 lb; take-off weight, 120,100 lb, with a limit flight load-factor of 3.0; landing weight (sinking speed 8ft/sec), 110,000 lb; (sinking speed 9ft/sec), 96,000 lb; zero-fuel weight (load factor 2.5), 99,100 lb; (load factor 3.0), 87,100 lb; operating weight empty, 59,800 lb to 63,800 lb, dependent upon operating role.

Personnel: crew (normal), 4; troops, 92; paratroops, 64; litters, 70, with two attendants; passengers, 55.

LOCKHEED C-130A HERCULES . . .

which would be provided by the door-sill is formed by a detachable floor extension which projects from the paratroop-door aperture. During egress, each soldier is protected by part of the aft portion of the landing-gear fairing which swings outward to act as a slipstream deflector—although, due to the high location of the inboard engines, he can jump clear of direct blast from the airscrew and the exhaust gases.

Placed high and well forward, the four crew members are compactly grouped on a flight deck to which access is gained by a short ladder-stairs, and a let-down stair-door in the port fuselage side. Large windows affording wide-angle vision for air-drop operations are situated forward, overhead, and on both sides of the crew compartment. Armour plating against small-arms fire is provided for the pilot and co-pilot. Flying controls are duplicated, and the throttle and airscrew controls, autopilot and secondary flight controls are mounted on a large central console. Functionally shaped handles of standardized design have been utilized, wherever possible, for flaps, landing gear and trim-tab controls. The flight-mechanic/technician is positioned behind and between the pilot and co-pilot, so that the instruments can be monitored without the need for a separate engineer's panel. The fourth crew member, the navigator, faces starboard and is provided with a large working table and instrument panel.

Standard flight instruments confront both pilots, and the engine panel is conventionally situated forward of the central pedestal. The lower section of the co-pilot's panel contains the grouped hydraulic controls, and additional systems panels are mounted overhead. A feature of the latter is the diagrammatic representation of the system on each panel, which is combined with the actual instruments and controls; the operation of the fuel and electrical systems is thus simplified. Checking the panel back from the windscreen the pilot has the engine controls, the fire emergency controls, the fuel and electric panels and the air-conditioning controls.

Undercarriage. The choice of a tandem-wheel geometry retracting vertically into the fuselage was made in view of the severity of the terrain from which the Hercules might be forced to operate. The arrangement is claimed to be particularly suitable for soft-field operation, since the compressing effect of the leading wheel tends to benefit its trailing fellow. Tactical landings on hastily-prepared unpaved airstrips are quite feasible, and field construction requirements are consequently minimized. The adoption of this configuration results in a fuselage of unusual strength, and consequently the protection in a wheels-up landing is appreciably increased. The problem of undercarriage stowage in a high-wing aircraft—the length of leg required—is thus neatly dodged, and Lockheed suggest that this solution also produces the least drag.

The main landing gear retracts vertically into the fuselage wheel-wells and is enclosed by a pair of doors on each side. During extension and retraction the gear runs in vertical tracks and is actuated by coupled hydraulic-motor-driven screw shafts, with emergency manual extension. Each main wheel is attached to an individually suspended length and is coupled by an extensible link. The dual-nose wheel gear is also hydraulically retracted, and the wheel-well doors are mechanically closed during retraction. Excellent handling characteristics in restricted areas are made possible by hydraulic power—through steering 60 deg each side of centre. The steering control is a small handwheel mounted on a long extension shaft just below the pilot's left armrest. Turns of 8.38ft radius at the wing tip or 35.8ft at the nosewheel can be achieved.

Powerplant. The Hercules is powered by four Allison T56-A-1 single-shaft turboprops, each developing 3,750 e.h.p. at take-off. The Aeroproducts (originally Curtiss) 15ft-diameter three-blade airscrews are of the constant-speed type, and are fully-feathering and reversible. They are driven through a gearbox of 12.5 : 1 ratio coupled to the four-stage turbine by an extension shaft. The installation includes fire- and overheat-detection systems. Access to the Allison installation is provided by cowling doors on each side of the nacelle, two centrally hinged panels on the upper cowling, and a rear-hinged single-piece panel over the wing. For increased take-off performance, eight jettisonable 14KS-1,000 type Aerojet Jato units may be fitted to the paratroop slipstream deflectors.

Systems. The use of the transport in an ambulance rôle required that the flight station and cargo compartment—which can accommodate 70 stretchers and two attendants—be both pressurized and air conditioned. Air for this purpose, which maintains sea-level cabin pressure up to 18,000ft and a final differential pressure of 7.5 lb/sq in (the cabin altitude at 35,000ft is 8,000ft) is bled direct from the engine compressors. The heating capacity, with automatic temperature control, is capable of sustaining an inside temperature of +70 deg F with an outside air temperature as low as −65 deg F. High O.A.T.s are also catered for; an air temperature of 100 deg F can be reduced to 80 within the interior. On the ground, heating and cooling air is generated by the AiResearch gas-turbine/compressor auxiliary power unit. Conveniently situated at chest height in the forward fairing of the port under-nacelle, immediately ahead of the wheel well, the compressor supplies air for ground starting. Additional air is also supplied for pneumatic power to the air-turbine motor from which the emergency hydraulic pump and D.C. generator are driven.

Fuel System. The basis of the fuel system is the integral sealed wing tankage, which—due to the inflammable nature of the sealing compounds used—is constructed in a special building. After three coats of sealing have been applied, and a pressure test carried out, the tanks are filled with Buna-N rubber compound and then drained, leaving a protective coating on the inside of the tank. The integral tankage capacity is 5,080 U.S. (4,225 Imperial) gallons, each outboard tank holding 1,062 Imp gal and each inboard tank holding 1,042 Imp gal. External pylon tanks for combat use hold an additional 2,331 Imp gal total, but the total allowable fuel is 4,413 Imp gal and not the aggregate of the capacities quoted. The pylon tanks are compartmented, having two individual supply systems and incorporated self-sealing blankets and explosion-suppression systems. The integral tanks each have their own purging system. Cross-feed arrangements, controlled from the cockpit panel (which combines a schematic diagram with fuel-flow controls), fuel gauges and warning lights, make it possible to feed any engine from any tank.

Pressure-fuelling from a single point at waist-level may be done in nine minutes. The single-point system, it is claimed, reduces the danger attendant upon carrying hoses to the upper wing surface. Located at eye-level is a ground control panel which indicates all the tanks to be refuelled and the quantity of fuel in each.

Electrical System. Advanced navigational radar devices contribute to reliable operation in all weathers. Equipment installed in the C-130A includes AN/APN-59 radar I.F.F. and V.H.F. command radio; radio altimeter and compass; Omni, glide-path and marker beacon receiving equipment; radar altimeter; emergency transmitter and keyer; interphone equipment; and public address, liaison communication and Loran systems. This equipment is served by suppressed aerials in the under-fuselage and fin, a nose radome and an external aerial between the fin and a point just aft of the flight deck.

Electrical power is furnished by a total of five 28-volt, 400-amp D.C. generators, two 40 KVA 407 three-phase alternators and a 24-volt battery. One of the D.C. generators is mounted on each engine, with the fifth on the gas turbine motor; the alternators are installed on the inboard engines. Single-phase power conversion is supplied by two 2,500-VA inverters and three-phase power by two 500-VA inverters, one unit of each type serving as a standby during normal operations.

Flying Controls. A feature of the Hercules is the use of power-assisted flying controls with a degree of manual reversion sufficient for "some measure of control" to be possible at low flying speeds. The aircraft can also be controlled in all flight conditions by means of independent electrically-operated tabs energized by the D.C. generator or the batteries. Control forces are stated to be "very light even at low flying speeds, and the combination of light forces with high inertia seldom gives the pilot any impression of sluggishness." It is interesting to note that the aileron and flap jacks are mounted in the wing centre section, actuating their respective surfaces through mechanical links. Much shorter links are used downstream of the rudder and elevator boosters.

Hydraulic System. As might be expected, the flying controls are on an individual "boost system" hydraulic circuit, but they are also operated from the "utility system" circuit which supplies pressure for flap and undercarriage operation, for the brakes and for nosewheel steering. Each of these systems is pressurized to the normal operating pressure of 3,000 lb/sq in by two hydraulic pumps; the boost-system pumps on engines one and three and the utility-system pumps on engines two and four. The boost pumps are of sufficient capacity for either to operate the flying controls alone. An emergency system for extending the flaps and undercarriage and operating the brakes and loading ramp (but not the flying controls, supply for which is duplicated from the main systems) is pressurized by a hydraulic pump driven by an air-turbine motor. This system has an independent fluid supply. The size of the two rear loading doors and forward cargo door is such that actuation is performed hydraulically, the power source being the utility system.

De-icing System. The leading edges of the wings and tail unit, engined air-inlet scoops and radome are de-iced thermally from air bled from the last (14th) compressor stage of each engine. Further use is made of the ubiquitous gas-turbine compressor to supply the various compartments of each engine installation with directly heated air to assist cold-weather starting by pre-heating the nacelle. Electrical heating is used on the airscrews, airscrew spinners and pitot tubes, and the windscreen is electrically heated by means of Nesa glass.

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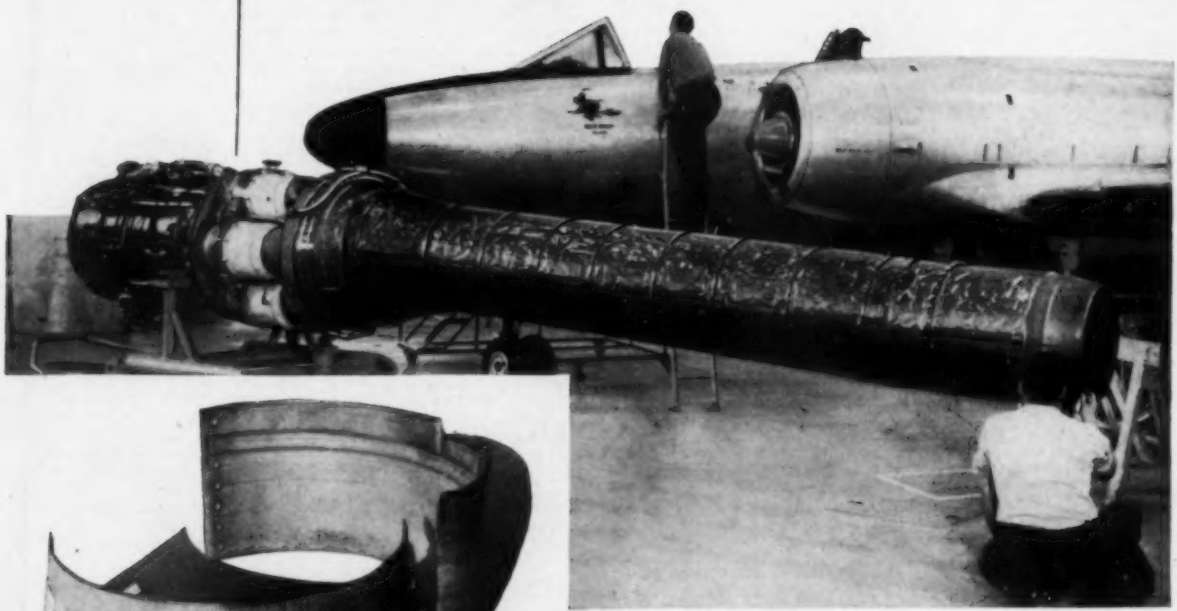

Jet pipe of an Avro-Canada Orenda turbo-jet with its Refrasil heat-insulating blanket encased in Inconel foil.

A typical insulating blanket made by the British Refrasil Co. Ltd.

Light alloys used for aircraft construction must be protected from heat radiated by the gas turbine and afterburner assemblies. To insulate efficiently with the minimum of weight a vitreous silica fibre, known as Refrasil, is frequently used, suitable for temperatures up to 1,100°C. The Refrasil batt is enclosed in an envelope of metallic foil to prevent risk of fire as a result of fuel or oil soaking into the fibre. Inconel is employed for the foil, while Inconel or Nimonic 75 may be used for the edgings or stiffener plates of blanket assemblies. The foil used is of 0.003 and 0.004 in. thickness, and on all edges it is turned over and seam-welded to ensure complete sealing. Inconel is a nickel-chromium-iron alloy possessing high strength and resistance to oxidation at elevated temperatures, presents no welding problems, and can easily be fabricated in thin gauges.

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SOARING IN ONTARIO

A Visit to the Toronto Gliding Club at Brantford

THE Canadian team at the World Gliding Championships at St. Yan this summer was made up entirely of members of the Toronto Gliding Club. This achievement is a reflection of the vigour with which the club—now Canada's largest—has progressed over the past few years, as well as of the experience and ability of its members. The notes and illustrations of the club's activities on this page follow a recent visit to the site at Brantford, Ontario, by Kenneth Owen of *Flight;* additional information has been provided by Norman Ring, president of the club, and Gordon Oates, vice-president.

Although a small amount of gliding had been performed in Canada prior to 1939, no real efforts were made towards setting up organized gliding clubs until after the war. Among the wartime emigrants who helped to spread the gliding gospel after the end of hostilities were a number of Polish engineers. The Toronto Gliding Club was formed in 1947 by a few enthusiasts, with the encouragement of Mr. B. S. Shenstone (now chief engineer of B.E.A.) and Mr. W. Czerwinski, who had been active in the field of sailplane design in pre-war Poland. Prior to this time, some gliding had been carried out at Downsview by some of the founder members in a primary machine known as the Sparrow.

Since then the club has continued to be active, although a few lean years have been experienced. During this period a single-seat training glider, the Loudon, was designed by Czerwinski, built by the University of Toronto and put into club service; and a number of American war-surplus Laister-Kauffmann 10A trainers were purchased. These have proved to be very durable two-seaters, with excellent soaring abilities.

During the club's history difficulties were experienced in finding a suitable site, and numerous airports (including Oshawa, Buttonville and Breslau) were sampled before the club settled in its present location at Brantford, some 66 miles from the city of Toronto. Membership has continued to grow through the years, and there are now approximately 75 active flying members, a number of whom have become private owners.

Annual flying hours and number of flights have increased from 92 and 335 respectively in 1947, to 750 and 1,500 in 1955. Among the many enthusiasts who have contributed to this growth are Jack Ames and Frank Brame, the Canadian pilots at St. Yan, who have been very active in directing and inspiring the efforts of the club members and who have been responsible for training a large number of Canadian glider pilots. The C.F.I. of the club is Eric Best, and there are about eight other voluntary instructors, most of whom are also tug pilots.

It was apparent from *Flight's* recent visit that the club's present site is in many respects ideal. The aerodrome at Brantford was built in connection with the Empire Air Training Plan, and is now operated by the Brant-Norfolk Aero Club. There are dual, paved runways in three directions, a clubhouse block, and plenty of hangar space to accommodate the club's sailplanes and other equipment.

Close co-operation has been achieved between the aero club and the gliding fraternity at Brantford. All gliding-club members join the Brant-Norfolk Aero Club, and the airport's dual runways enable simultaneous operation to take place (gliders on right-hand circuits, powered aircraft to the left). A recent joint effort was an air show organized by the two clubs to raise money for the world gliding championships team.

At the time of our visit (June) the club fleet consisted of two LK-10A two-seaters, one LK-10A single-seater conversion, one Schweizer 2-22 two-seater, one Loudon single-seater and (under construction) one Schweizer 1-26 single-seater. Privately owned aircraft consisted of one Schweizer 1-23D, two Schweizer 1-23s, Baby Bowlus, Schweizer 1-19, LK-10A (modified) and Schweizer TG-3. Two Tiger Moths, one of which is privately owned, are used for aero-tows. Since that time the Loudon and the Schweizer 2-22 have been destroyed in a gale, which also badly damaged the privately owned Laister-Kauffmann. Steps have been taken to replace these losses.

An interesting feature of the club's organization is that there are two classes of active membership. Flying members pay $20 per year, plus charges for tows and an hourly flying rate; while sustaining members pay $75 per year, plus tows, but fly club aircraft without charge. Most new members are in the first class, while the second category consists of older members who help in the club's operations. All the club's business, including maintenance and repair of equipment, is carried out by sustaining members.

Soaring conditions at Brantford are generally good, although this year's weather has been undistinguished. At least once a year a group of members travel down to one of the U.S. meetings at Elmira, New York, and sample winch launches and slope soaring. Last November the club brought back from Elmira the Snowbird Trophy, awarded to the club flying the most hours on the hill during the annual Snowbird Meet.

Some of the more recent members have been immigrants from Europe with considerable gliding experience, and the club has taken on a truly international flavour—which means really that it is truly Canadian. The membership is now almost equally divided between those who were born in Canada, in England, and in other parts of Europe. Canada's gliding movement is going ahead strongly, and the Toronto Gliding Club—now in process of changing its name to the Southern Ontario Soaring Association—is happy to be among the leaders.

At Brantford Aerodrome, Ontario, the Toronto Gliding Club and the Brant-Norfolk Aero Club share facilities and operate in close association. Top left, a Piper Tri-Pacer is refuelled as aero-towing by Tiger Moth takes place in the background; above, Schweizer 1-23 (foreground) and 1-23D in the hangar; left, one of the Laister-Kauffman LK-10A two-seaters about to be launched. All launches are by aero-tow, the tug machines consisting of two Tiger Moths. Brantford is about 66 miles from Toronto.

Maps and Minerals

Survey Techniques by Prince and DC-3

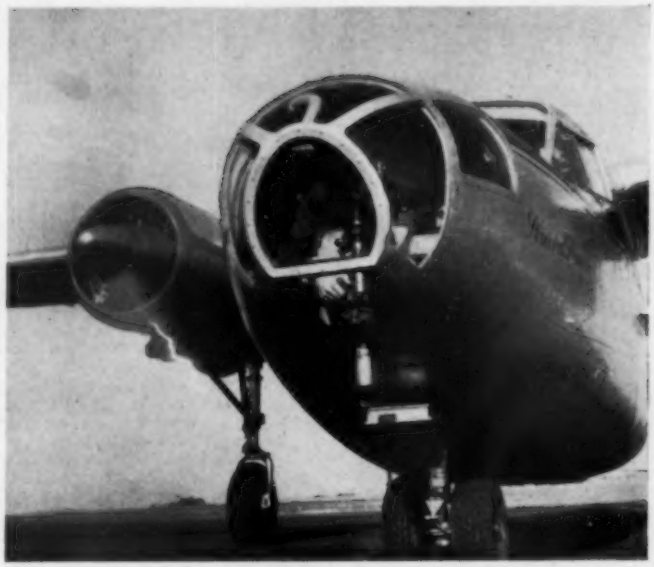
ON July 13 we published a brief description of the use of electro-magnetic mineral-prospecting equipment in the DC-3 G-AMYW operated by Hunting Geophysics, Ltd. The following article treats of the subject in greater detail, showing what is involved in aerial mapping as well as in mineral surveying—especially from the point of view of the pilot working over difficult terrain.

AIRBORNE geophysical survey is a particularly interesting branch of applied flying which has developed greatly over the last seven or eight years, and has already given spectacular results in several parts of the world.

Its object is the detection of oil and sub-surface metal ores—an important assignment, because the actual consumption of minerals by world industry is growing at the rate of some five per cent every year, and consumption now is vastly higher than it was at the beginning of the last war. Such were the quantities of base metals—that is, iron, nickel, copper, lead and zinc—used up during the peak war years 1944/5 that it was generally felt the same rate could not continue with the return of peace. But this was a mistaken impression, for consumption has steadily risen, as have metal prices; and there is a very real danger of world-wide shortages unless the rate of mineral strikes is maintained.

The difficulty is, of course, that the world is still a very big place. This may seem a flippant observation upon a serious subject, but one can have no idea of the immense size of lonely areas where prospecting has never been carried out, and where the problems of maintaining communications are sometimes made the more severe by rough climates. The old-time prospectors, with their hammers, shovels and pack-ponies, used to spend years out in the bush searching for surface deposits; but most of these easily-found ore bodies have, in fact, by now been found and exploited. Attempting to locate new ones (buried beneath, perhaps, a hundred feet of overburden in the middle of inaccessible, rocky country) on foot or even by Land Rover—assuming it could get through—would be altogether too slow today. What is needed is some method of carrying out a thorough, rapid reconnaissance from which a minerals inventory showing what is likely to be there—and, what is more important, exactly where it lies if it is there—can be produced. Airborne geophysical methods can provide that inventory, and that is why the science has assumed such importance.

A Prince at work—showing diagrammatically the method of carrying out vertical air-to-ground photography for mapping purposes.



The camera operator in a Hunting Survey Prince checks the Williamson Eagle IX camera drift/aiming sight before take-off on a sortie.

A geophysicist is a man who is concerned with the physical properties of rocks—their density, their elasticity, their magnetic permeability, and so on. His knowledge is complementary to that of the geologist, who studies the earth's structural properties as a whole, and the ways in which minerals occur in association with each other; the latter has only a limited ability to assess the nature of sub-surface structures and relies upon his colleague's interpretations of geophysical measurements to determine what lies beneath the top-soil.

Now there are three of these physical properties which can be conveniently measured by sensitive electronic equipment mounted in an aircraft—magnetic permeability, electrical conductivity, and radio-activity. The instruments used to record this data are also used on the ground, but for initial "inventory" surveys this is slow, arduous and expensive in forested or mountainous terrain—over large areas the cost can be five times as great as the airborne method—and is, in some respects, technically inferior. The task, however, of these instruments, whether from the ground or the air, is to detect the difference in physical properties between an ore body and its surrounding rock; and to illustrate the way in which a survey is planned and flown, a search for electrically-conducting ores—concentrations of lead, zinc, copper and nickel sulphides—can be taken as an example. Their probable locations are directly disclosed by the electromagnetic detector—E.M. for short—the latest addition to the flying prospector's arsenal, and by now a highly developed electronic device of great sensitivity.

The starting-point of every airborne mineral survey should be a complete vertical photographic coverage of the entire area. If it does not exist, and is specified by the client, the coverage is secured by a Survey Prince or Hudson (depending upon whether U.K. or Canadian Hunting companies, respectively, are engaged) mounting Williamson Eagle IX or Wild RC 5a cameras. The quality of the photography, secured from between 15,000 and 25,000ft and giving scales of 1:30,000 to 1:50,000, is very high; and so important are photo-interpretative techniques to the geologist that photogeology has become a speciality in its own right. Surface rock structures show up beautifully on the mosaics—controlled to the degree of accuracy required—constructed from the 9 × 9in contact prints, and patterns or tones which might be associated with valuable ore bodies, are at once apparent to the trained eye. These mosaics are used constantly throughout the survey, and the navigator of the geophysical aircraft may carry a set for low-level contact navigation.

Basically, a geophysical survey is carried out by flying the aircraft across the area in a series of parallel lines at a constant height above ground level, while the continuously recording equipment collects its data. The planning of the flight pattern, or the direction in which the parallel traverses run, is very much a geologist's job; he first of all studies the general geological situation as revealed by the vertical photographs, considers this in relation to any definite knowledge of the area which may have been acquired by surface drilling or ground sampling, and then plans a series of aircraft traverses which should give the best

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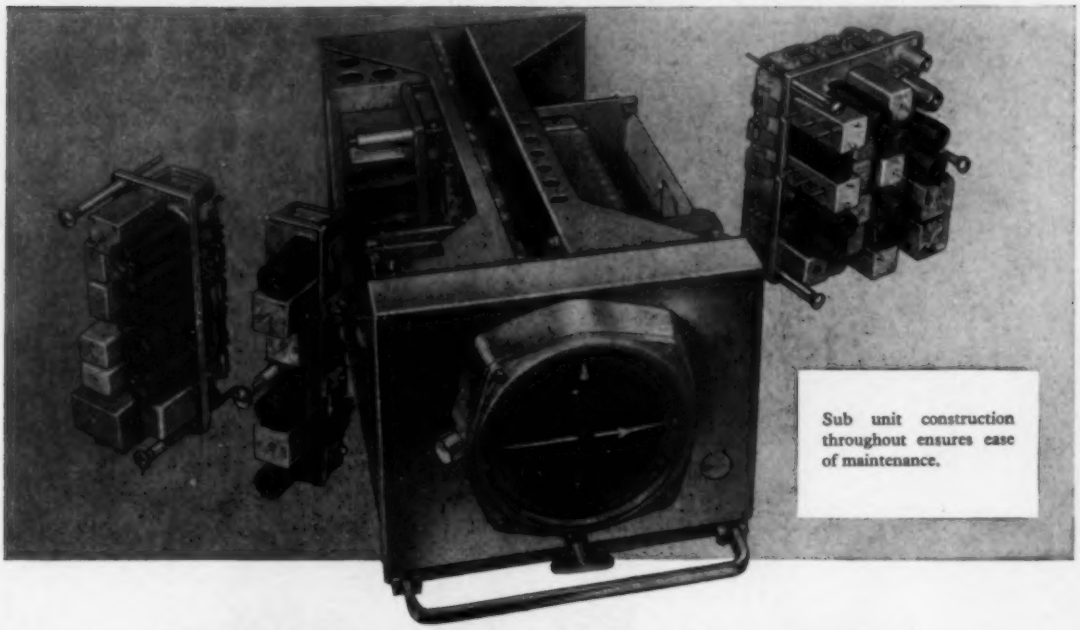

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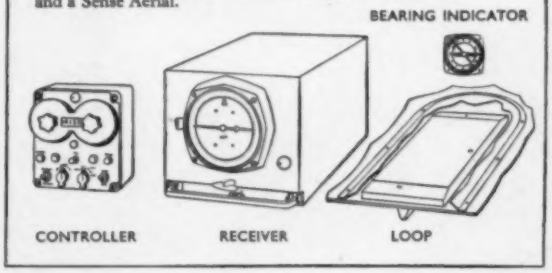

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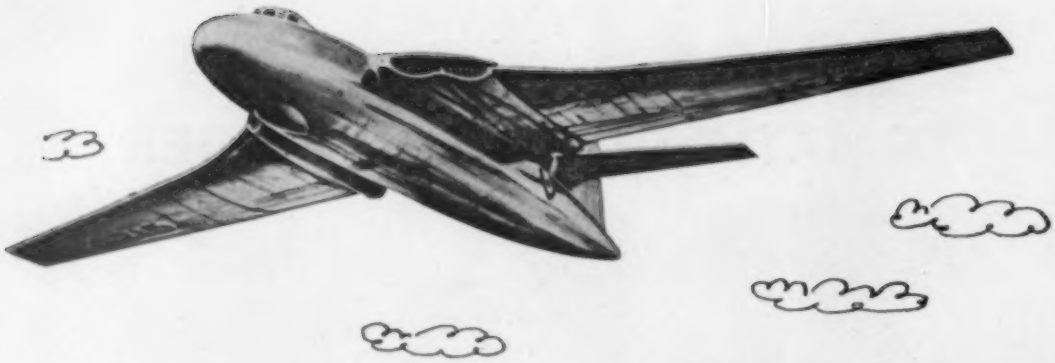

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MAPS AND MINERALS . . .

results. As a general rule, traverses should be at right angles to the strike of a formation (such as a line of high ground raised by a "folding" of the earth's surface), but in some folded areas a radial flight pattern may be recommended. Then, again, as happened recently in Northern Europe where the rugged nature of the terrain prevented sufficiently accurate height-holding, a further coverage down steep-sided valleys and along the edges of ravines can be flown at right-angles to the first one at a different altitude.

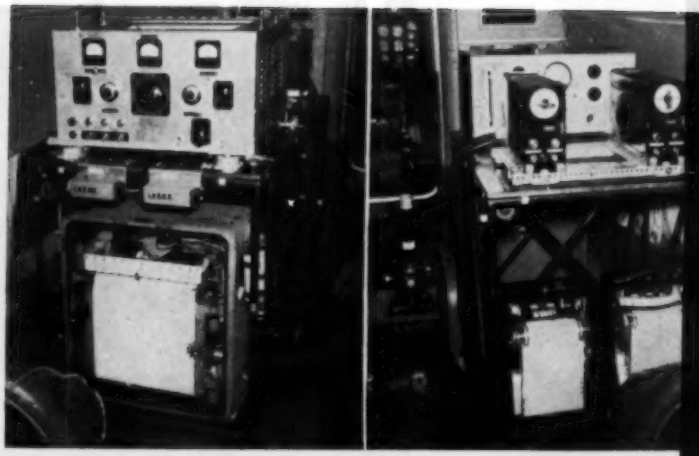
The electromagnetic detector weighs 1,127 lb and has three main components; an external primary coil, mounted between the trailing edge of the aircraft's wing and the tail, or extended by spreaders along the top of the fuselage; a secondary coil, carried in a streamlined "bird" and towed on 500ft of cable; and an internal electronic installation contained in a large console with a graphic recorder in its face. Into the primary coil is fed A.C. at two frequencies—2,300 and 400 cycles per second—and the aircraft thus becomes the centre of an alternating electromagnetic field, which can penetrate 300ft down into the ground under favourable conditions when the aircraft is at 500ft. If a conducting ore body—such as a copper, nickel or lead sulphide deposit—is beneath, it will have eddy currents induced in it and re-radiate a secondary field, which is detected by the towed secondary coil. The phase-shift between primary and secondary fields is measured and continuously recorded by a laterally-travelling pen on a moving belt of graph paper in the console before which the E.M. operator sits.

The reason for recording phase-shifts at two frequencies is that the response of various conductors varies with the frequency of the energizing field. The low frequency will penetrate more deeply than the high, and therefore the plot of the latter will show up surface conductors such as lakes, swamps and man-made structures as well as surface ore bodies. The low-frequency plot will also show these, but it will react more strongly to deeper—and potentially more valuable—areas of conductivity. It is therefore the simple ratio between H.F. and L.F. phase-shifts which will tend to indicate the best conducting ore deposits.

Flying Technique. There are interesting points about geophysical flying. It is essential that a reasonably constant proximity of equipment to ground surface be maintained, and 500ft ± 50ft is considered suitable for conductivity surveys. Over rolling country, this can mean a certain strain for the crew, though positive and negative g-loads are not serious and the pilot's chief preoccupation is not to let the towed "bird," which flies 250ft below and 200ft behind the aircraft, touch ground. (The "bird" is precisely positioned at a point within primary and re-radiated fields where electrical "noise" is at its lowest value.)

When coverage of the area begins, the navigator becomes the key crewman. He uses large scale 1 mile=2½in maps, or mosaics, upon which the flight pattern has been ruled, in alternating numbered red and blue lines to eliminate confusion. For complete E.M. coverage a line-spacing of ¼ mile or 220 yd is called for, and maximum permissible error is 70 yd to port or starboard of track. If this is exceeded the whole line must be reflown, and the problems involved can be appreciated when it is considered that over a three-mile traverse in hilly country abrupt wind-changes causing alterations in drift are frequently encountered. In order to deal with this, the flying and engineering members of the U.K. company quickly devised and installed a drift sight in their recently-equipped E.M. DC-3; mounted on the scuttle before the second pilot/navigator, it projects a point of light at infinity in the manner of a gyro gun-sight and computes drift alterations very rapidly.

Flying geophysical coverage can be likened to a protracted low-level bombing run lasting perhaps eight or nine hours; and a very high degree of skill is necessary to keep within height and track limits. The aircraft is literally "hopped" from one identifiable ground feature to the next, the navigator pointing out landmarks to the captain and drawing his attention to the next point on track. The exterior equipment reduces a DC-3's cruising speed by some 15 kt, and stick forces are slightly



Two views of the E.M. "works" aboard a Survey Prince. At right, the recorders of the scintillation counter and radio altimeter; on the left, the magnetometer console.

higher; booster pumps are switched on, mixture set in auto-rich and convenient engine settings for the low-level run in are 2,100 r.p.m./28in Hg. With one eye on the radio altimeter and both hands on the column, the pilot lifts the aircraft over rising ground with up to 35 or 36in boost, and throttles back slightly going downhill on the other side.

With every type of mineral survey flying it is essential to know exactly which ground-point gave rise to each geophysical measurement, and therefore a vertically-mounted 35 mm Vinten positioning camera is carried. This takes overlapping exposures of track made good, and after a specified number of frames exposed (usually ten) it emits an electrical pulse which makes a fiducial mark on the edge of the recorder graph paper. Radio-altimeter readings are also continuously recorded beside the E.M. high and low frequency phase-shift measurements, and so when the reduction stage is reached, proximity variations can be compensated for.

The E.M. equipment used by Group companies was developed by PSC Applied Research, Ltd., of Hunting Associates in Toronto, and in the Canso aircraft of Aeromagnetic Surveys, Ltd. (Hunting Associates' geophysical specialists), has uncovered ore deposits worth many millions of dollars in Canada alone. Under favourable conditions, 1,500 line miles a day have been flown by them (not taking transit or positioning turns into account), though five weeks is reckoned to be the usual period for a 10,000 line-mile survey—allowing for bad weather.

So successful were the tests of the recently introduced equipment in Hunting Geophysics' E.M. DC-3 over the southern half of the Isle of Man, during which all known ore bodies were pin-pointed and others hitherto unknown revealed, that a contract has been placed for the coverage of the remainder of the island. After this, the aircraft is scheduled to go abroad for an extensive period.

The Hunting DC-3 equipped for mapping and survey work. On top of the fuselage are masts for E.M. equipment; protruding from the tail is the fixed detector head of a magnetometer on a 12ft boom; and trailing below the aircraft is the bomb-like sensing coil.

All in the day's work for Hunting Geophysics' survey crews. Typical of the terrain over which they may have to fly is this desolate, sharply ridged Middle East mountain ridge.

MAPS AND MINERALS . . .

Airborne Magnetics and Radiometry. Conductivity, however, is but one of the measurements that can be made. There is another type of data which is recorded, using precisely the same flying technique to help geologists assess the location of iron, oil, asbestos, titanium and nickel deposits. This is the continuous measurement of the earth's magnetic field at every point in the prospecting area, which (contrary to what is generally supposed) varies strongly from place to place. The measuring instrument is the magnetometer, and since the total force type in use by the Group is considerably lighter (500 lb) and more compact than the E.M., it can be carried in specially-modified small twin-engined aircraft. Hunting Percival Survey Princes equipped with the magnetometer have carried out successful magnetic surveys in Europe, Africa and the Middle and Far East, including Australia, for mining and oil companies, though unfortunately "client security" means that nearly all results are strictly classified.

One exception to this rule, however, was the magnetic survey carried out by a Survey Prince 3a in Norway for a well-known mining company. The object of the search was ilmenite, a titanium ore, and though turbulence and the excessively dissected nature of the terrain made height-keeping very tricky, the coverage was achieved within three weeks, and the magnetic data sent back for interpretation. At the first of several points which the magnetometer had indicated to be potentially fruitful, the company's drills disclosed over 100 million tons of high-quality ilmenite.

The instrument consists of a detector head, mounted in a streamlined fairing in the extreme tail of the aircraft, and a console in the cabin with a graphic recorder, similar in principle to that of the E.M. installation. The detector mounts three flux-gates mutually at right angles to each other on a gimbal system, two of the flux-gates aligning the third (measuring) one in the earth's field by means of a servo-motor. Metalliferous ores with high magnetic permeability, such as magnetite (a valuable pointer to iron-rich ores) or pyrrhotite, and many igneous rock types as well, exert a "twisting" effect locally on the earth's field, and as the aircraft flies through these variations at constant height a.g.l. the flux-gate system becomes unbalanced. This stage of unbalance induces a voltage in the secondary coil of the measuring flux-gate which is proportional to the magnitude of the field change, and the servo-motor, electronically monitored, re-aligns the system. This airborne instrument is very sensitive, being able to detect field changes of the order of 1-2 gammas (1 gamma = 10^{-5} gauss), and its detecting system operates instantaneously, no matter what manoeuvre the aircraft may carry out.

Though it can detect the probable presence of magnetic ores, it is nevertheless a fact that the magnetometer is far more widely used for "indirect" work, that of mapping rock structures which can by an examination of aerial photographs be shown to be associated with possibly valuable, yet unmagnetic, minerals. The geologist uses every sort of data which may be to hand: any known geology of the area, photo-interpretation, geophysical measurements and surface sampling at points which the mosaics will enable him to choose. From the magnetometer measurements he will be able to assess the shape and possible nature of geological structures beneath many feet of overburden, and thus be in a position to infer what mineral wealth is there, and how deep it lies.

As with the E.M., an essential ancillary instrument is the positioning camera, and the flight plan is arranged to allow the magnetometer to be flown back to a selected ground point or "tie line" after every few traverses, so that instrument drift can be recorded and corrected.

The third type of physical data which can be conveniently collected is radio-activity, and this is measured by the scintillation counter. Mounted in Sycamore and Sikorsky helicopters, Auster Autocars (U.K.) and Cessna 180s (Canada and South Africa), these small instruments have a detector probe comprising a thallium-activated sodium iodide crystal in optical contact with a photo-multiplier tube, the scintillations of the crystal being amplified and fed through a time-constant circuit to a graphically recording rate-meter. Valuable deposits of exploitable radio-active ores are being disclosed by this instrument, notably in Brazil, and also latterly in the Philippines, when a Survey Prince carried out an aeromagnetic/radiometric survey. The scintillation counter can detect 35 millionths of an ounce of radium from an altitude of 200ft when travelling at 130 kt.

A significant recent development—bearing in mind the foregoing remarks about the importance of all available data in the assessment of an area—is the installation of all three types of instrument in one aircraft. For the first time in Europe, a Hunting Geophysics, Ltd. DC-3, structurally modified, carries E.M., scintillation counter and magnetometer and operates them all simultaneously. Apart from the saving of time, the great advantage is that all three types of data are collected along the same flight-line, and are thus comparable to one another, so allowing the geologist to draw his inferences with far more certainty. Recorded on to rolls of continuously moving graph, therefore, are conductivity measurements at high and low frequency, magnetic permeability, radio-active emanations and radio-altimeter measurements, while the 35 mm positioning film synchronizes with both recorders by electric pulsing. The whole installation weighs 2,000 lb and is looked upon as the most sensitive fast prospecting tool yet produced.

Interpretation. The reduction and interpretation stages which follow the flying take a good deal longer. When the graph paper is removed from the recorder at the end of a sortie, the data is in "profile" form, and reduction involves converting it into contoured geophysical maps. This is done by plotting the Vinten positioning photographs on the original mosaic of the area, which bears the flight pattern, and entering alongside each the corresponding magnetic, conductivity or radiometric value, whichever is the case. Points of equal intensity are then joined up to form contours, thus revealing the "anomalies," or departures from prevalent intensity, upon which the geologist will concentrate.

The interpretation of those anomalies, and the task of assessing their significance, may take many weeks and is a highly specialized art; but the outcome of the studies involved will be a minerals inventory map which would have taken years to produce by ground investigation alone.

H. S.

WOMEN PILOTS' RALLY

THE British Women Pilots' Association is holding a flying meeting at Sandown, Isle of Wight, at the weekend of September 22-23. Accommodation has been arranged for the Saturday night and plans are being made to ferry members across who cannot fly from the mainland. An Autocrat, a Magister and a Tiger Moth (plus instructors) will be available and there will be spot-landing, circuit, navigation and technical-knowledge competitions. All women pilots and guests, it is stated, will be very welcome, even if only for a short visit; further details can be obtained from the secretary of the Association, Miss Janet Ferguson, Chetwode, Higher Denham, near Uxbridge, Middlesex.

D.H. "OLD BOYS" CELEBRATE

THE de Havilland Aeronautical Technical School Old Boys Association—a wordy title more usually condensed to "Tech. School Old Boys"—discovered some years ago that a gala summer dance was about the pleasantest way yet devised of holding a reunion. To any D.H. man, apparently, this dance is a "must" event on the aeronautical calendar, and it is not surprising that tickets for the most recent of these happy occasions were at a premium some while before August 31 when the event was held. The venue this year was Astwick Manor, home of the Technical School bordering Hatfield Aerodrome, but the skilful decorations and excellent supper were much as before.

PUB/R/10/56

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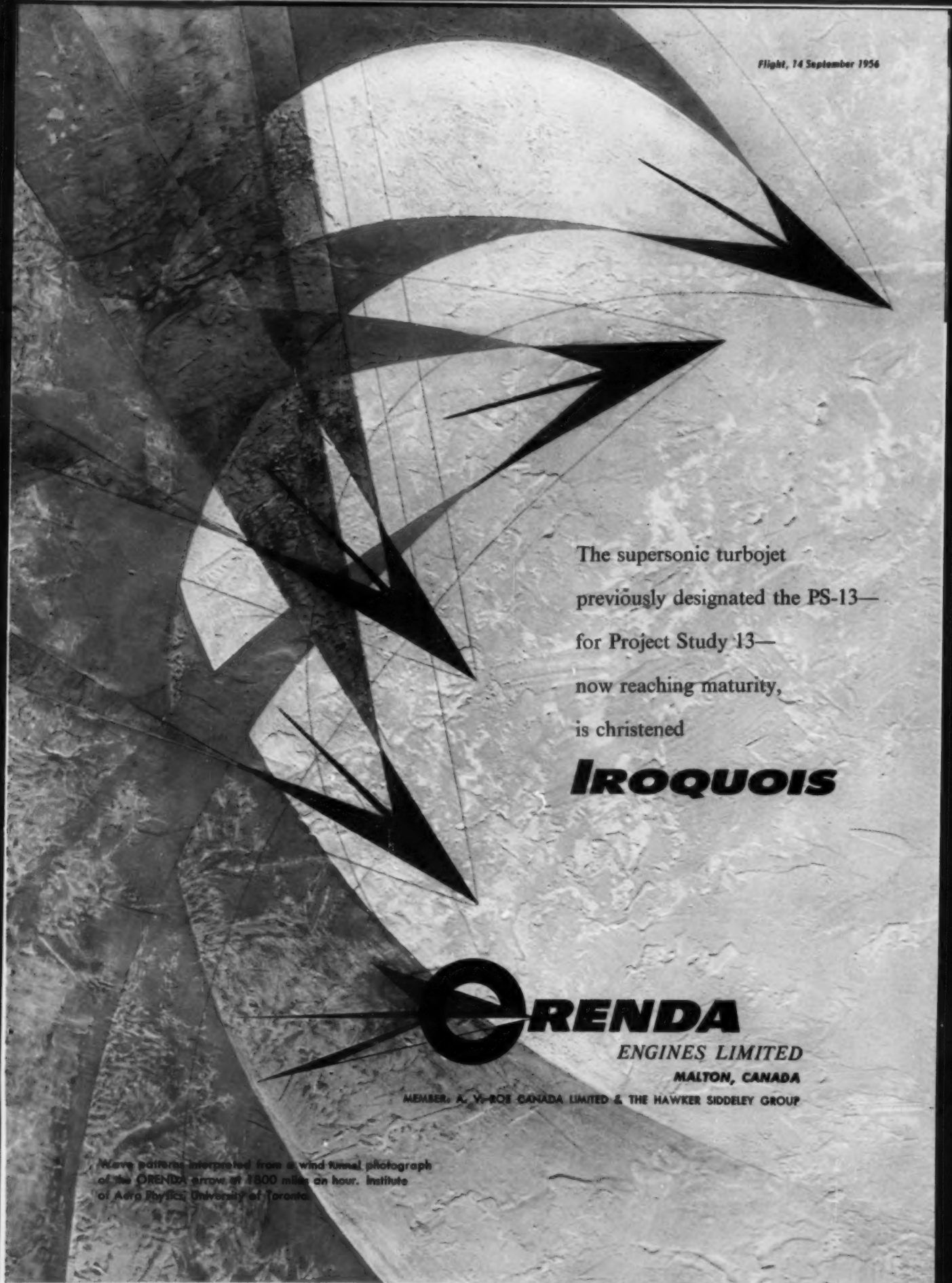

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CIVIL AVIATION

FOUR VISCOUNT ORDERS IN A WEEK

THE Viscount order book rose from 346 to 356 last week when three new orders and one repeat order were received by Vickers-Armstrongs, Ltd. (1) Trans-Canada Airlines asked for two more 700Ds (type 757) to bring the T.C.A. Viscount fleet to 38. (This was the Canadian company's fourth separate order to date.) (2) Lloyd Aero Colombiano, whose order for Handley Page Heralds was announced eighteen months ago, bought three 700Ds for delivery starting in the early summer of 1957. Lloyd Aero's Viscounts will be used on new routes from Bogota to Kingston, and to Bolivia by the new and shortest overland route *via* the Amazon. (3) Another South American order came from the Brazilian Government, who purchased one Viscount from Vickers and another, by private sale, from Braathens S.A.F.E. of Norway. (4) A third South American order came from P.L.U.N.A., Uruguay, for three 700Ds. They will take delivery from December 1957.

WRAPS OFF THE DC-9

FOR many months a small team at Santa Monica have been working on the Douglas Model 1925, a short- to medium-range transport using engineering solutions pioneered by the larger DC-8. In our issue of July 6 we published all that could be said of this aeroplane, which the world's airlines have been studying with avid interest. Douglas have now reached the final design stage and have released basic data for publication.

A three-view drawing is indistinguishable from that of the DC-8—with the following exceptions: speed brakes are repositioned on the flanks of the lower fuselage behind the wing; there are only 18 cabin windows on each side; and paired mainwheels replace the bogies of the DC-8. Dimensions are roughly 80 per cent of those of the long-range machine. It is worth noting that the DC-9 is an appreciably smaller machine than Convair's Model 880 (originally known as the Golden Arrow), which has a maximum weight of 173,500 lb.

The most interesting part of the DC-9 specification is the choice of the Pratt and Whitney JT8 turbojet, the commercial derivative of the Navy-developed J52. As we noted in our "Aero Engines" issue of May 11, the J52 has never been a major project and the JT8—a typical split-compressor Pratt and Whitney engine—will need considerable development for airline use. The obvious choice for the DC-9 is, of course, a lightweight, derated Avon developed from the RA.29.

There would be little point in describing the aircraft in detail, since the specification very closely follows the layout adopted in the DC-8, which was fully described and illustrated in *Flight* for July 6. In the figures given in the table, thrust reversers are assumed not to be fitted; Douglas state that each reverser would weigh 100 lb and that noise suppressors for the propelling nozzles would weigh 35 lb each.

Douglas DC-9.—Medium-size transport seating 74 (four abreast) in standard form. Powered by four Pratt and Whitney JT8 turbojets each rated at 7,500 lb thrust

Dimensions: span, 112ft 9in; length, 118ft 8in; height, 35ft 4in; track, 17ft 8in; wheelbase, 42ft 7in; tailplane span, 38ft; distance from centre-line to engine axes, inboard 252.8in and outboard 443.6in; fuselage outside cross-section, 144in high by 130in wide.

Weights: maximum gross, 134,000 lb; maximum landing, 105,000 lb; total usable fuel, 58,570 lb; space-limited payload, 21,340 lb.

Performance: typical cruise operation, 2,425 nautical miles taking off at maximum weight with 37,500 lb of fuel, at a mean block speed of 483 kt at 35,000ft. Block speed varies from 350 kt at 300 n.m. to 460 kt at 3,000 n.m., the maximum cruising t.a.s. being 503 kt (579 m.p.h.) at 120,000 lb at 30,000ft on 85 per cent power. Design level Mach above 29,500ft is 0.88. Landing field length (C.A.R.4B) without reversers is given as 5,550ft at sea level at 105,000 lb.

A Note on Boeing's Small Jet

It is pertinent, in view of the statement on the DC-9, to repeat *Aviation Week's* contention that Boeing will soon announce their entry into the field of small jet-transports with "a number of firm orders for a smaller version of the 707" (see *Flight*, May 11). Powerplants are expected to be either General Electric CJ805s, each of 10,000 lb thrust, or the Bristol Orpheus (we must leave readers to draw their own conclusions here, in view of the fact that the Orpheus gives half the thrust of the G.E. engine). The new Boeing is to be suited to stage lengths from 300 to 2,000 miles, will be able to use short fields, and cruise at over 600 m.p.h.

Going aboard to resume Britannia proving trials on August 29 were Capt. J. E. Jackson; Walter Gibb, Bristol's assistant chief test pilot; and Mr. H. Stringer, service manager of Bristol Aero Engines.

TAKE A JET INTO PARTNERSHIP

LAST January it became known that Fairchild, of Hagerstown, Maryland, had decided to design and make, as a private venture, a mock-up of a small eight-seat jet to try out on the executive market. Last week first details of it were published—and with them came an announcement of a firm order for three from the Continental Can Company. Fairchild hope to sell 600.

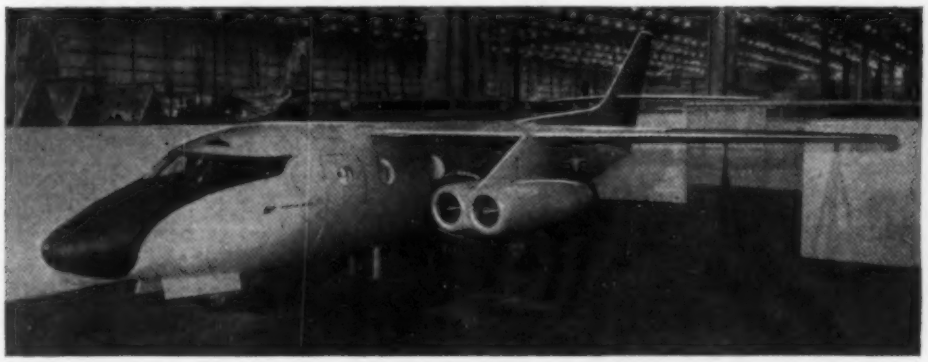
Known as the M-185F, it is a small 540-m.p.h. eight-seater, powered by four twin-podded 2,000 lb-thrust Fairchild J83s, with G.E. J85s as an alternative installation. First flight will be late 1957 or early 1958, with deliveries about eight months later—an uncommonly quick schedule. Preliminary brief details of the project, which represents yet another invasion of the airscrew's preserves by the jet, are as follows:—

Fairchild M-185F. Span, about 57ft; length, about 56ft; fuel tankage, 1,800-1,900 U.S. gal; cruising speed, about 540 m.p.h.; three-engine climb, 1,700-3,000ft/min; ceiling, 45,000ft (35,000ft on three engines); range, 2,530 st. miles with 70 m.p.h. headwind and 30 min reserve; price, about £350,000.

HELICOPTER OUTLINE

THE final report of the U.S. Air Transport Association's committee on rotorcraft gives recommendations for civil helicopter development that agree very closely with the recommendations put forward by I.A.T.A. earlier this year. Two distinct types of helicopter are envisaged by both bodies; one a relatively short-range (75 to 100 miles) 25-passenger machine capable of supplementing ground transport and the other a larger 35-50-passenger machine which would be used for scheduled air transport on inter-city services where facilities for the operation of fixed-wing aircraft are lacking. The essential need for safe operation was recognized by requirements from the A.T.A. calling for multi-engined types which would be capable of round-the-clock operation in all kinds of weather.

Both conferences have recognized the urgency of designing helicopters with operating economies in keeping with the "flying bus" concept which will attract the short-haul market with low fares based upon low costs. It is suggested that interiors and passenger appointments should be particularly simple and easy to maintain, and that the design of doors should be such as to speed up the entry and exit of passengers—an important step toward reducing non-revenue time on the ground.



"The businessman's jet" is the obvious classification of the Fairchild M-185F project, of which the mock-up (bearing the markings of the U.S.A.F., whose J83s will power it) is seen here at Hagerstown, Maryland. Details appear above.

CIVIL AVIATION . . .

B.O.A.C. REPORT POSTSCRIPT

FOLLOWING the publication of B.O.A.C.'s Annual Report and Accounts (which was reviewed in *Flight* last week), a Press conference was held at which Mr. Gerard d'Erlanger, the airline's chairman, commented upon the difficulties which the Corporation was experiencing in holding their share of the world's airline traffic with the aircraft they had available. He went on to discuss the re-equipment which would be needed if B.O.A.C. were to maintain their position as a leading international operator.

Particularly on the North Atlantic routes, the chairman said, the position must be regarded as very serious, for lack of competitive aircraft in 1960 would put B.O.A.C. "virtually out of business" on these routes. A downward trend in the percentage of traffic carried by the British corporation between the United Kingdom and the U.S. and Canada has been apparent for some time; it is at present 28 per cent, but B.O.A.C.'s share of the traffic should, the chairman felt, amount to about half of the total. The aircraft required for these services, the American Boeing 707 or Douglas DC-8, although powered by Rolls-Royce Conway engines, would cost about £2m each with spares provisioning; but they should pay for themselves within five years of being put into service—and it should not be overlooked that the lion's share of the tickets sold would be paid for in dollars.

Mr. d'Erlanger, discussing new equipment for B.O.A.C., said that he saw no obvious alternative to buying one of these types of aircraft—in fact an option is held on one of them (formerly an option was held on both types). In this he is strongly supported by Sir Hudson Fysh, the chairman of Qantas, the Australian airline which operates services to Australia fed by, or in conjunction with, B.O.A.C. Sir Hudson said recently, on arrival in this country: "If B.O.A.C. does not order either the Boeing or the DC-8 I fail to see how it can remain in competition on Atlantic routes. . . . My corporation . . . is dependent on B.O.A.C. for feeding it with U.K. and European traffic." Commenting upon his then-forthcoming meeting with Mr. Harold Watkinson he said: "I shall do anything to . . . consolidate the Qantas-B.O.A.C. partnership."

Mr. d'Erlanger said that in so far as competitive British aircraft were concerned, discussions had taken place on a Conway-powered Comet, and although such an aircraft could not be ready until 1962, it "was under consideration." Looking further ahead, he considered that the next logical step forward was to supersonics. The size of aircraft would depend, he said, on the level of fares which must be provided, since for the first time it was expected that the additional speed of these aircraft would not offset their additional expense. Some "very nebulous preliminary talks" had been held with various British manufacturers. Added to current B.O.A.C. difficulties was the problem of London Airport Central, which, said Mr. d'Erlanger, was now "clearly inadequate," particularly in respect of the parking space available for both aircraft and cars and the airport buildings which would not accept greatly increased passenger traffic. These problems were now being discussed by an M.T.C.A. committee.

HANSEATIC HIATUS

THE revival of West Germany's airline, Lufthansa, has meant re-appraisal of the operating rights which were accorded to the Scandinavian Airlines System at a time when aviation in Germany was banned. Germany's main bone of contention has been the transit rights which permit S.A.S. to use Hamburg and Frankfurt as stopping points on its remunerative North Atlantic and South American flights, and to operate services to South Africa, the Middle and Far East in addition to a large number of internal German air services. The Scandinavians, who have considerable capital invested in DC-7Cs (they have 14 on order), have somewhat naturally insisted upon cabotage, and they resent any interference which might lose them Continental passengers. Furthermore, they argue, Lufthansa are not yet in a position to take over S.A.S. traffic and this would consequently go to French, British and American operators.

After three days of "tense" discussions, a new civil air convention—embracing West Germany, Norway, Sweden and Denmark—has been agreed. "The negotiations," said the Danish Prime Minister, who presided, "were very difficult and the results not satisfactory to either party." The new convention, which will run from next October until August 1958, curtails the S.A.S. intermediate stops on the North American route from 12 weekly at Hamburg to six weekly during the summer and four in the winter. Only one stop will be made at Bremen, although the original German proposal was to reduce the S.A.S. stops at Hamburg and Frankfurt to a "symbolic" number, and to increase the use of secondary airfields by the Scandinavian line. The operating conditions for the less important traffic to Africa and the Middle East and Far East remain unchanged.

The "concessions" evoked sharp criticism of Dr. H. Seebohm (the West German Transport Minister) and his delegation by Lufthansa, who claimed that they were "obviously made for political considerations and would adversely effect the development and aims of Lufthansa."

Rolls-Royce recently bought from their keen rivals the D.H. Engine Company four Gipsy Queen 30 Mk 2s. To them were attached this Heron, luxuriously furnished for business use by the firm's executives.

IS 500 m.p.h. THE TURBOPROP'S LIMIT?

THE answer to the question as to whether the speed of turboprop airliners will ever be substantially greater than 500 m.p.h. is perhaps best answered by the airscrew experts. Both Rotol and de Havilland have had something to say on this subject, and we quote the views of Mr. L. G. Fairhurst, chief engineer and technical director of Rotol, together with those of Mr. P. Brett, chief project engineer of de Havilland Propellers, Ltd.

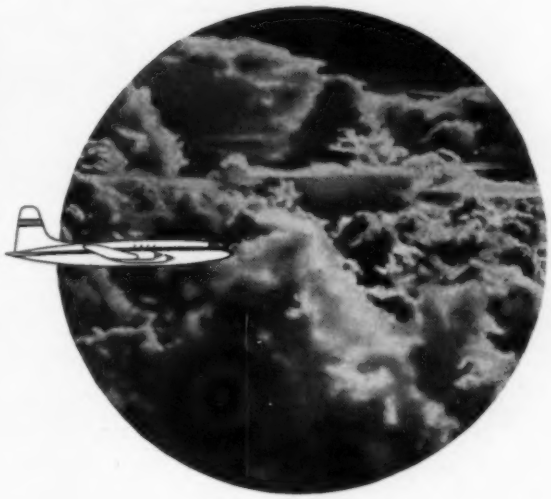
In a Royal Aeronautical Society section lecture earlier this year, Mr. Fairhurst showed that airscrew efficiencies of about 80 per cent were attainable at speeds of about 500 m.p.h. at 40,000ft. The problem that arose was whether such efficiencies could be maintained at up to, say, 600 m.p.h. It was questionable whether a "transonic" airscrew (subsonic for the greater length of the blade but supersonic at the tips) would still be an "efficient proposition" at 600 m.p.h. Efficiency might fall to 60 per cent, although if r.p.m. were increased at the expense of higher compressibility losses, it might be raised to about 68 per cent. And if the hollow steel blades were very thin, a further recovery of efficiency would bring it "comfortably back into the picture"—although this airscrew would now be supersonic over the greater length of its blades. The pure-supersonic airscrew might, with blades (perhaps solid-steel) of still further extreme thinness, achieve 70-76 per cent efficiency at 600 m.p.h. However, Mr. Fairhurst stated, the most serious objection to the supersonic airscrew was its "extremely high" noise level, "which at the present level would be entirely out of the question."

Mr. P. Brett, chief project engineer of de Havilland Propellers, also in an R.Ae.S. section lecture, pointed out that noise level rose rapidly as tip Mach number increased above 0.95; and since aircraft Mach number at 500 m.p.h. above 36,000ft was 0.76, it was clear that r.p.m. must be low to keep airscrew-tip Mach number down. Good sound-proofing and phase-synchronization (in which the corresponding blades of different airscrews are maintained in a constant angular relationship) could achieve an acceptable noise-level provided that the tip Mach number did not rise above 1.0. Very wide blades would be needed to provide the necessary power-absorption at the low r.p.m. required (of the order of 750 r.p.m. if tip Mach number was to be limited to 1.0 at an aircraft speed of 500 m.p.h.). Furthermore, blades would have to be very thin to reduce compressibility losses. Beyond a flight Mach number of 0.8, Mr. Brett continued, it became impossible to absorb all the power without tip Mach number increasing beyond 1.0. The airscrew then became truly supersonic, and would have very thin blades. But, he said, supersonic airscrews would inevitably be "extremely noisy—so much so in fact that their use for airline operation appears to be virtually out of the question."

The experts' view, therefore, seems to be that cruising at much beyond 500 m.p.h. above the tropopause (36,000ft plus) will require supersonic airscrews; and that although such airscrews are aerodynamically and structurally feasible, they would, for civil use, be unacceptably noisy. Nevertheless, it might be inferred that flying at *lower* altitudes of around 20,000ft would, at tip Mach numbers of 1.0, permit cruising speeds—albeit noisy ones—of at least 550 m.p.h.

EKCO electronics for aviation

The growing use of high-speed aircraft has focused attention on the value of Search Radar for weather-avoidance. Already, the B.O.A.C. Britannia Fleet is being fitted with EKCO Search Radar, a 3cm equipment which provides early warning of potentially dangerous cloud formations, warning of high ground in the flight path and provides map-painting facilities to assist navigation.



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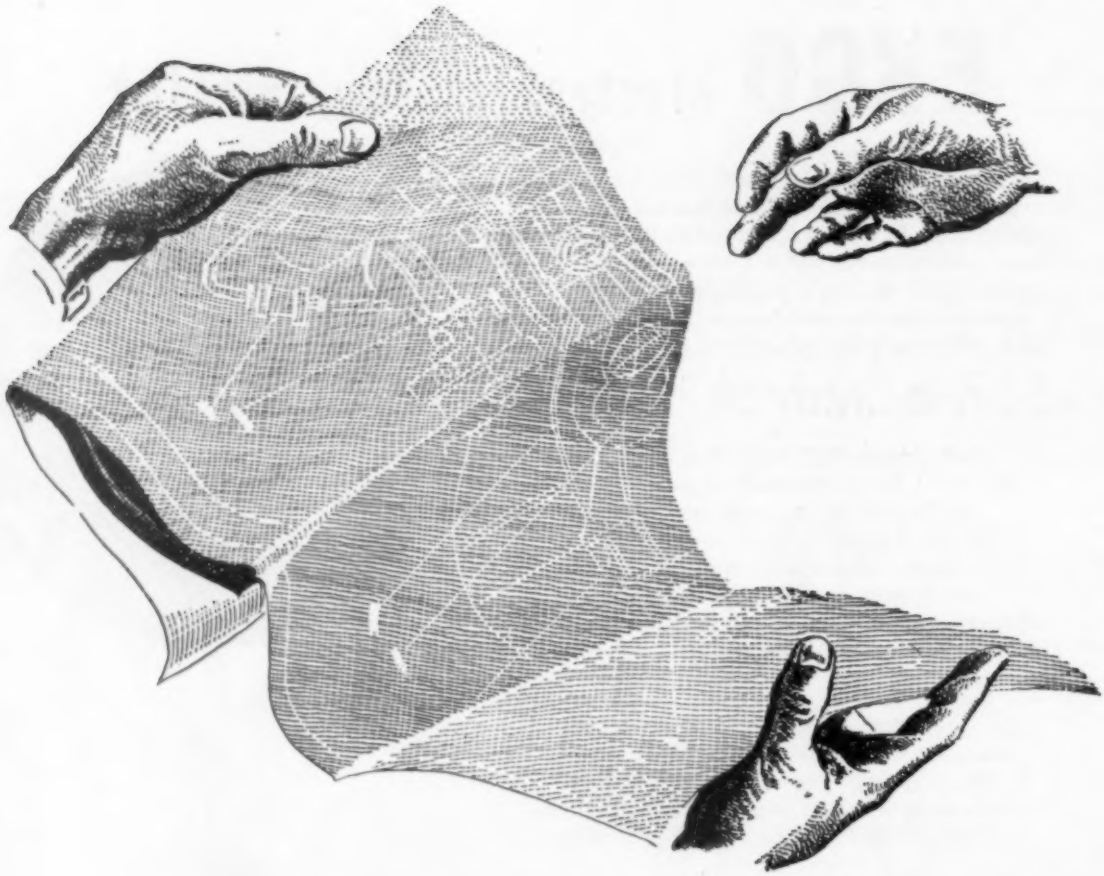

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CIVIL AVIATION . . .

BACK TO BRISTOL

SEVERAL items of Britannia interest emerged from the news conference held at London Airport by Mr. Peter Masefield on August 31. The occasion was the arrival home of Britannia G-ANBJ from its 19-day, 78 flying-hour tour of the United States and Canada. Some idea of how the aircraft impressed its hosts can be gained from a remark by Mr. Eddie Rickenbacker, president of Eastern Air Lines, to the effect that the 24,000-mile tour (taking the Britannia to New York, San Diego, Los Angeles, Vancouver, San Francisco, Denver, Chicago, Miami, Washington, Ottawa and Montreal) would have been quite a feat for even a proven piston-engined airliner to complete without any serious snag. About 40,000 people walked through the aircraft (which now needs a new carpet) and about two dozen demonstration flights were made for airline officials. The Britannia brought home to England Mr. George Gardner, president of Northeast Airlines who, significantly (see *Flight*, August 31) have just been granted permission to operate the highly prized New York-Miami route. Mr. Masefield confirmed that (as we forecast last week), B.O.A.C. will release its seven 302/5s, and take three more 312s in their place, to enable new customers to receive delivery next year.

Captain J. Meagher, who captained the aircraft throughout its tour, made a remark of interest to future jet operators: the Britannia had to wait 50 min on the Idlewild runway before taking off on its homeward flight—"quite a normal occurrence."

Confident and hopeful was the bearing of the Bristol men who brought back the Britannia from its U.S. tour on August 31 (see adjacent news item). Welcoming the team were, left and right respectively, Mr. Basil Smallpeice of B.O.A.C. and Sir Reginald Verdon Smith of Bristol. To the left and right of Mr. Peter Masefield are Mr. W. R. Farnes, a director of Bristol Aircraft, Ltd., and Mr. A. Symon, Britannia design manager. Captain J. Meagher of B.O.A.C. (not in this group) was captain of the aircraft throughout its tour.

BREVITIES

A TWIN Pioneer is shortly to undertake a demonstration tour of the U.S., including Alaska. A "single" Pioneer has already been shipped to America for demonstrations. The Twin Pioneer structural test specimen, "without a single rivet shearing," has just completed its final C. of A. structure test—100 per cent loading in the "50ft/sec upgust" case. As recorded in last week's issue, the aircraft may have been awarded its full C. of A. by the time these words are read. More than 510 hours have now been flown on the first three aircraft, the latter two of which (as recorded last week) appeared at Farnborough in the colours of de Kroonduif (KLM-New Guinea) and Swissair.

* * *

As forecast in last week's issue, Air-India International has bought three Boeing 707-420s (Conway engines). This was announced in Seattle last week, and it takes the 707 score book to 110 aircraft sold. (This brings 707 sales to exactly the same as DC-8 orders, which until now have been ahead of the 707.) Rolls-Royce announced at Farnborough last week that Air-India had chosen Conway engines.

* * *

A Caravelle is due to make a tour of the U.S.A. next year.

* * *

Quebecair is reported to have placed an order with Fairchild for two Friendships. The president of T.P.A. Aloha Airlines, Hawaii, is due to visit Fokker in the near future with a view to placing an order.

* * *

B.E.A.'s first Viscount 802 G-AOJA, which is still undergoing maker's tests, was shown to the Corporation's staff at London Airport on August 31. Lord Douglas flew in the aircraft.

* * *

Manx Airlines, the Isle of Man operator, has been acquired by Britavia. The company will continue to operate as before.

* * *

It is stated that the Handley Page Herald may be added to the two DC-3s and three Rapides operated by Manx Airlines, whose acquisition by Britavia is reported above. Air Kruise, also a Britavia subsidiary, has six Heralds on order.

* * *

Fifteen people on board a Canadian Pacific DC-6B were killed when the aircraft crashed at Cold Bay in the Aleutians on August 30. There were seven survivors.

* * *

PanAm and Aeroflot signed an interline ticket agreement in Moscow last week. No operational agreements have yet been concluded (see *Flight* for September 7).

CLUB AND GLIDING NEWS

THE Tiger Moth battles which were such a feature of this year's air races were revived at Elstree on Saturday, September 1, on the occasion of the first gathering of the Tiger Club (the "Tiger Tims") at the summer convention of the Association of British Aero Clubs—an over-formal title for a pleasantly intimate flying meeting. Cold and blustery weather reduced the number of contenders for a cup, presented by the A.B.A.C., for the winner of a secret time-of-arrival competition, which was won—most appropriately—by 68-year-old J. M. Donald, who had flown down from Newcastle. Mr. Donald also took a very active part in the rest of the afternoon's proceedings, which consisted of two heats and a final around the three laps of the four-mile "Elstree circuit" (revised to avoid the contestants "looking into the bedroom windows" of two elderly ladies). Before the racing began, C. Nepean Bishop gave one of his outstanding displays of aerobatics, making good use of the freshening wind to aid his customary excellent positioning. This performance, including as it did the now well-known five-point loop, was much appreciated by everyone present.

Elstree have a pleasantly light-hearted way of being efficient, and the Tiger races that followed were run with a maximum of enjoyment and a minimum of fuss. Six pilots flew the four "competition" Tiger Moths and the two heats eliminated the contestants down to three—David Ogilvy and Bill Bailey (both Elstree instructors)—and Beverley Snook, who is a well-known Tiger Tim. In the final, Ogilvy managed to overtake his fellow instructor in an exciting contest which gained much by being in view of the spectators throughout. Bill Bailey's racing technique is somewhat similar to that of his C.F.I., and occasioned from several knowledgeable voices the hope that more air racing will come his way. All the finalists received prizes—and the ingredients of a good party—from W/C. Maile, who reminded the convention that next year—the 25th anniversary of the Tiger Moth design—would be celebrated with another Tiger Moth race at Sandown, I.o.W., and by an aerobatic contest for which de Havillands will award a prize.

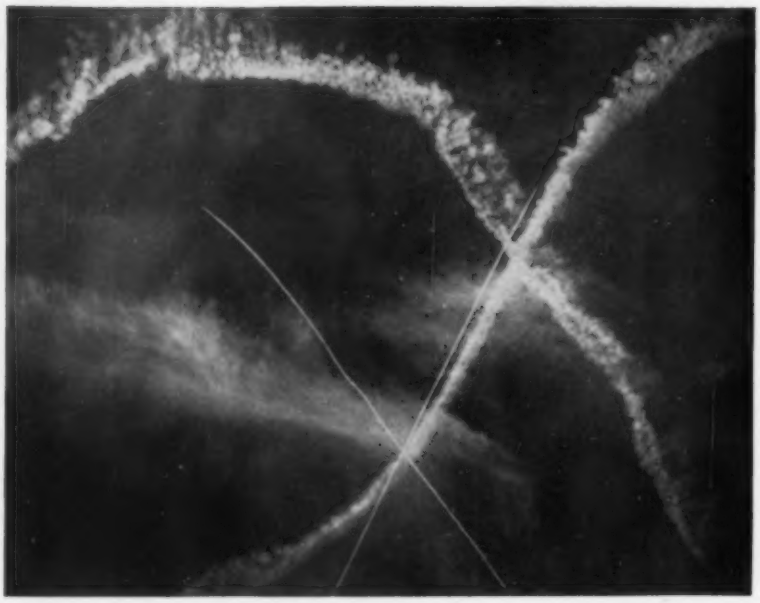
AMONG the first civil-conversion de Havilland Chipmunks soon to begin flying with British clubs are G-AOSY (Elstree Flying Club) and G-AOTG (Surrey Flying Club).

A LOCALIZED rain-squall and Eastleigh Flying Control combined to keep the defending aircraft grounded during what was to have been the Hampshire Aeroplane Club's tea patrol last month. On the aerodrome, club pilots watched helplessly as the attackers joined the circuit and landed. Having had their previously arranged dawn patrol rained-off in July, club members are now reportedly considering flying a Christmas Dinner patrol. A new club contest this month is for maximum altitude, with Tiger Moth or Hornet Moth but without oxygen equipment.

LASHAM Gliding Centre—"now that the summer is officially over"—reports impressive figures of activity for the first eight months of 1956. The number of launches has risen to 15,805 compared with 12,923 for the same period of last year; flying hours are 2,674 as against 2,162; and cross-country flights total 6,339 miles compared with 3,652.

SERVICE AVIATION

Royal Air Force and Fleet Air Arm News



Delineated by contrails are practice collision-course attacks by two Avro Aircraft CF-100 Mk 5 fighters. The aircraft were manoeuvring over the makers' Malton factory.

Battle of Britain Service

THE Battle of Britain Service of Thanksgiving for the victory won in 1940 will be held in Westminster Abbey on Sunday, September 16, at 1500 hr. The Queen will be represented by Air Chief Marshal Sir John W. Baker, G.B.E., K.C.B., M.C., D.F.C., A.D.C.

On his way to the Abbey to attend the service, the Chief of the Air Staff, Air Chief Marshal Sir Dermot Boyle, K.C.V.O., K.B.E., C.B., A.F.C., will lay a wreath at the R.A.F. Memorial on the Victoria Embankment. Contingents of the Royal Air Force, Women's Royal Air Force, Princess Mary's Royal Air Force Nursing Service, the Royal Observer Corps, Royal Artillery, Royal Engineers, Women's Royal Army Corps and the Royal Air Forces Association will parade for the occasion.

No. 9 Sqn. Standard Presentation

A STANDARD will be presented to No. 9 Squadron at R.A.F. Binbrook on Tuesday, October 9, by Air Chief Marshal Sir Hugh Pughe Lloyd. The ceremony is timed for 1145 hr. A cordial invitation is extended by the squadron to all former members, and those wishing to attend should communicate as soon as possible with the Adjutant, No. 9 Squadron, Royal Air Force, Binbrook, Lincolnshire.

Auxiliary Commanders

THE following are among appointments to commands in the R.Aux.A.F. recently announced by the Air Ministry (others will be included in a forthcoming issue):—

S/L. C. D. Bartman is commanding No. 602 (City of Glasgow) Sqn. He joined the R.A.F. in 1941 and served with various units before joining No. 245 Sqn., No. 83 Group. In 1947 he joined No. 74 Sqn., converted to Meteors, took the C.G.S. course and became weapons officer at Horsham St. Faith. In 1952 he joined No. 257 Sqn., and three years later took the all-weather flying course at Manby. Before taking up his present appointment he completed the Hunter conversion course at Chivenor.

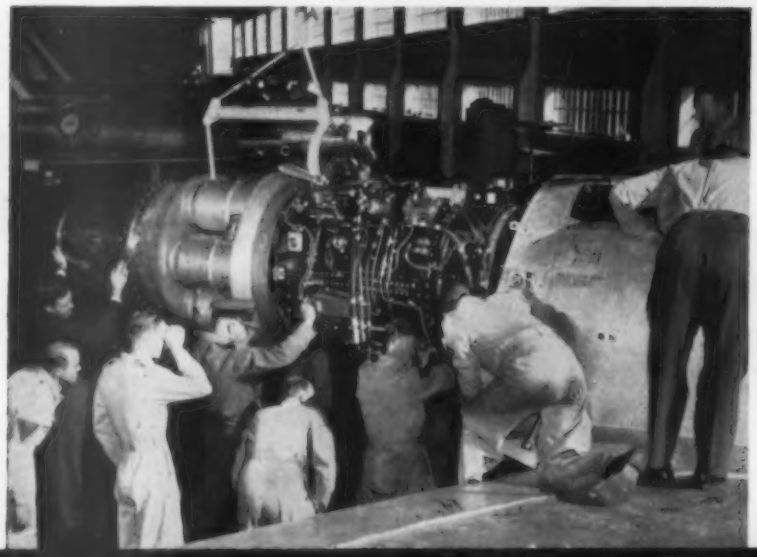
S/L. M. E. Hobson, a regular officer, is commanding No. 603 (City of Edinburgh) Sqn. He joined the R.A.F. in 1944 and served with Nos. 92 and 257 Sqns. in 1947. He converted to Meteors and took the C.G.S. course. He was adjutant of No. 603 Sqn. in 1952.

S/L. G. Gray, a regular officer, is commanding No. 607 (County of Durham) Sqn. He enlisted in 1940 and served with No. 111 Sqn. during the war. After the war he served with No. 1 Sqn. and in Rhodesia. In 1952 he was with No. 66 Sqn. and became adjutant of No. 502 (Ulster) Sqn. in 1955.

S/L. E. J. Cream is commanding No. 2502 (Ulster) Field Sqn., R.Aux.A.F.Regt. He enlisted in 1942, joined the Regiment in 1946 and became a member of No. 2502 (City of Belfast) L.A.A. Sqn. after his release from the Service in 1947.

S/L. R. Birrell is commanding No. 3511 (City of Dundee) F.C.U. He enlisted in 1941 and served during the war with No. 605 Sqn. and at No. 51 O.T.U. After his release in 1946 he joined the R.A.F.V.R. and then No. 66 Group Reserve Centre. He transferred to the R.Aux.A.F. in the Secretarial (Intelligence) branch in 1953.

The first installation in South Africa of an Orenda 14 turbojet in a Canadair Sabre 6 of the South African Air Force. Other Sabres of the S.A.A.F. batch are seen in the background.



Vintage Foregathering

AT the third reunion of the Royal Flying Corps and Royal Naval Air Service, held at the Hyde Park Hotel, London, on August 31, no fewer than 520 members put in an appearance. Welcoming the R.F.C. contingent was Air Chief Marshal Sir Philip Joubert de la Ferté, and Rear Admiral R. Bell Davies greeted the R.N.A.S. party. To draw guests' attention to the platform there was G/C. "Tim" Morice, complete with genuine Gnôme cylinder crash-gong—a piece of apparatus familiar to anyone who served in either air Service in the First World War.

With so many well-known air types attending, the speakers found it impossible to mention names; but Sir Philip did espy among his listeners W/C. Lionel Cohen, who, he said, was the oldest—at 81—D.F.C. holder present. During the last war W/C. Cohen persuaded the authorities to allow him to become a rear-gunner. In this capacity he flew on 17 operations and received the D.F.C. when he was turned 70—a long way from flying Voisins in the 1914-18 affair.

For an observer it was interesting to look around and see what some of the young 1914-18 pilots had achieved. A glance embraced Marshal of the Royal Air Force Sir William Dickson, Chief of the Air Staff; in the centre of the floor Sir Alan Cobham of Empire flights, air circus and Flight Refuelling fame; Major Chris Draper, exponent (quite recently) of flying under Thames bridges; Capt. G. A. Lingham, one time sky-writer on S.E.5s and now a director of the Heston Aircraft Co.; and Capt. Cyril Uwins, silver-haired as he has been these thirty years, who for so long was Bristol's chief test pilot and is now managing director of their aircraft division. By

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D.T.D.825	34A/200512	NS-275	MIL-G-3278	LOW TEMPERATURE GENERAL PURPOSE GREASE	CALTEX UNI-TEMP GREASE
D.T.D.870	34A/200516	NS-277	MIL-A-3383 (AMEND. 1)	HIGH TEMPERATURE GREASE	CALTEX HIGH TEMP GREASE
D.T.D.866	34A/629152	NS-295	MIL-G-7421A	LOW TEMPERATURE GREASE (-100°C)	CALTEX LOW TEMP 1088 GREASE

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D.ENG.R.D. 2485 (ISSUE 1. AM.1) GRADE 115/145				
D.ENG.R.D. 2482 (ISSUE 2. AM.1)	34A/100649	AVTUR		
D.ENG.R.D. 2486 (ISSUE 2)	34AV			
D.ENG 2489				

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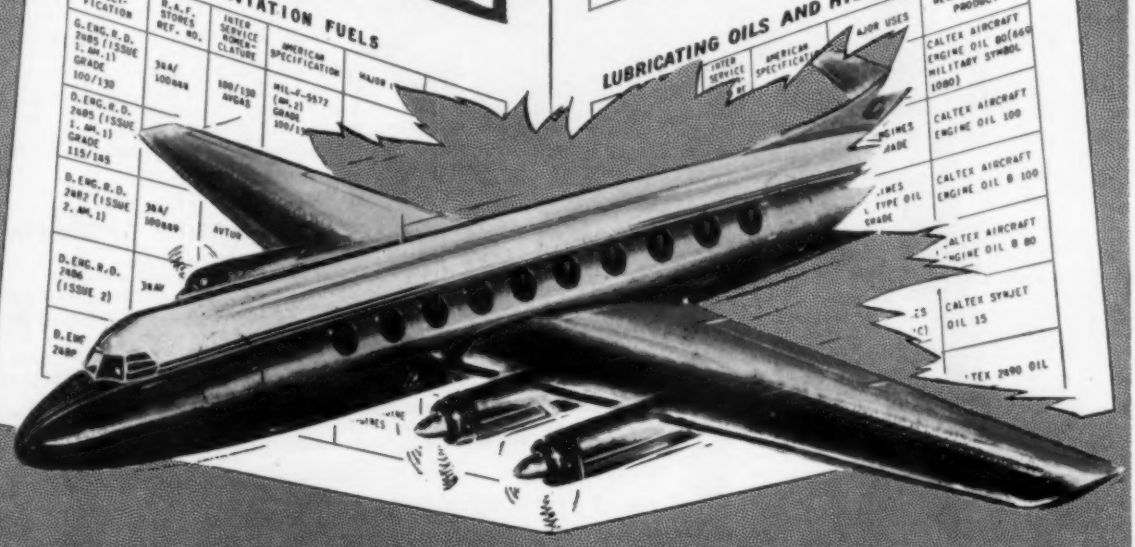
		...ES ...C)	CALTEX SYNJET OIL 15
			...TEX 2090 OIL



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"Flight" photographs

(Top left) E. B. Smyth, of No. 16 Sqn., who spent most of a week in no man's land after being shot down, swaps reminiscences with George Bulman. (Top centre) Three R.N.A.S. and one R.F.C.: S/L. C. H. Potts, now retired from Vickers; G/C. T. H. England, for many years H.P. chief test pilot; Fairey Aviation director L. Massey Hilton and W/C. R. H. Stocken, ex-C.F.S. instructor and aircraft consultant. (Top right) Two R.N.A.S.: W/C. L. M. Bailey with Sir William Dickson. (Lower left) W/C. R. J. O. Compston and W/C. L. Cohen—who, perhaps to emphasize a youthful 81 years of age, wore a red carnation. (Lower centre) Capt. C. F. Uwins with A. N. Stratton and Capt. H. S. Broad. (Lower right) Sir Philip Joubert gives the toast of the Royal Flying Corps; on his right are Capt. E. Keith Davies and—the taller of the two—G/C. C. S. ("Tim") Morice of the Dunlop Aviation Division.

SERVICE AVIATION . . .

the door could be seen Capt. Laurence Pritchard, now retired from his very efficient secretaryship of the Royal Aeronautical Society; G/C. F. C. V. Laws, father of photo recce and now chairman of Air Survey Co. Ltd., and, complete with beard, Capt. O. P. Jones, doyen of airline pilots.

Taking up a little more than his entitlement of space was G/C. "Jimmy" Jeffs, who now knows all there is to be known about air traffic control; and in the corner, no more bald than when a test pilot at Farnborough in the early twenties, was G/C. "George" Bulman, who, as chief test pilot and executive at the time of the Fury, Hart and Hurricane, did so much towards bringing the Hawker concern to its present prosperous state.

This successful function was organized by a committee consisting of W/C. J. C. Cantrill, Major R. H. Mayo, S/L. J. C. C. Taylor and Capt. H. S. Broad, under the chairmanship of Capt. E. Keith Davies and with G/C. C. S. Morice as secretary.

Reunions

THE eleventh annual reunion of No. 85 Squadron will be held in London on November 10, 1956. Particulars from J. Roberts, 14 Carisbrook Close, Enfield, Middx.

The annual reunion of No. 208 Squadron, R.A.F. (formerly Naval 8) O.C.A., will be held on October 27 at The Swiss Hotel, 53 Old Compton Street, London, W.1. Time, 6.30; running buffet tickets 7s 6d each, from R. W. Booker, 28, Greet Road, Lancing, Sussex.

CORRESPONDENCE

The Editor of "Flight" is not necessarily in agreement with the views expressed by correspondents in these columns; the names and addresses of the writers, not for publication in detail, must in all cases accompany letters.

Rotodyne Pros and Cons

THANK you for publishing my letter on the Rotodyne. The comments put forward by the author of your original Rotodyne description call, I feel, for a reply.

I am certainly not overlooking the fact that the Rotodyne is an exceptional combination—though whether of virtues or vices remains to be proven.

My figure of 1½d per seat mile is what *could* be achieved by a "properly designed short-range fixed-wing aircraft" (quoted from my letter) working at 3,000 hours per annum utilization. Whether an operator has ever achieved such a utilization on a stage distance of 100 miles I do not know; nor do I know whether there is any more likelihood of its achievement if he uses a Rotodyne. I am fairly certain that such a cost could not be reached with a Dakota, which, after all, was designed more than twenty years ago for ranges of 500 miles. I agree that it certainly would not be achieved by a jet-lift machine; I didn't say it could—but I think that a "simple fast *aeroplane*, fitted with jet lift" (for take-off and landing only, of course—quoted from my letter) might well produce lower costs than the compound helicopter, though not so low as the fixed-wing aeroplane.

Why this desire to operate from city centres? Who lives there? All the people who live between London's centre and its western edge would probably rather have London Airport where it is than at Charing Cross. Surely what is really wanted is more airports around city perimeters. This would assist in relieving the ever-increasing congestion in the air whereas centralization will only make it worse. Again, who wants to operate from a field (as opposed to an airfield)? Have you ever tried driving a car in a field during an English summer? To provide the ordinary facilities demanded by modern civilization your "field" will rapidly become an "airfield." How long the runways have to be, of course, is another matter altogether.

Finally, I am well aware that a steel rotor *need* not carry a weight penalty—what I suggested was that, whatever it be made of, it might carry such a penalty if designed to last as long as the rest of the airframe.

Belfast. SLIPSTICK.

Dollar Reflections

AS an ordinary citizen, knowing nothing about aircraft except what I read in *Flight*, I have been a very intrigued onlooker in the battle of the Correspondence columns between "Favonius" v. "Icarus" and the Editor, and the letter published on Friday, August 24, has really rung a bell—an alarm bell—in my mind.

As an onlooker, I consider that both the Editor and "Favonius" are right, but that "Favonius" is more right than the Editor.

Your editorial ("Balance Sheet," August 17) suggests that the British industry cannot develop too many different types of aircraft as it is too small. Agreed. But it does not ask the next question, namely, how many types of civil airliner must we produce? Answer: one long-hauler, one medium-hauler and one feeder liner. At the moment we appear to have no fewer than four aircraft being built and offered for sale which are all classed as medium-haulers,

CORRESPONDENCE . . .

the Viscount, Vanguard, Britannia and Comet 4A. If we can make four medium-haulers, surely we can produce just one long-hauler? And whilst on the subject let us remember that the long-hauler of today often becomes the medium-hauler of tomorrow. Dakota, Constellation, DC-4 and 6, all were the pride of the trunk routes but are now frequently used as medium- and short-haulers; and now the Comet and Britannia join in. It won't be many years before we see the DC-8 and Boeing 707 on the shorter routes. If the Comet can be made into an economical proposition over 200-mile routes, then why not the DC-8 or Boeing 707? And as the American air seems to be overcrowded, the answer to expansion there seems to be the same number of bigger machines, and not more 60-seaters. Agreed that this may be where we score, as the rest of the world may not be ready for 120-seat aircraft yet; but if we want to stay in the forefront, we must build for the trunk routes. It should not be very difficult for de Havilland to produce a Comet 5 for sale in 1961; and they have the advantage of knowing the opposition, as they can build better landing and take-off performance into their aircraft—and perhaps other advantages, such as larger freight holds. Rumour already has it that the Comet 5 is in hand. Many operators, including Commonwealth lines, have not placed orders for big jets yet. Do not prejudice a possible Comet 5 by your remarks.

As for B.O.A.C., their equipment policy is very difficult to follow. They order Britannias and then order Seven Seas as an insurance policy against the Britannia—which didn't help Bristols in their sales drive. Now they will be introducing the Britannia and Seven Seas simultaneously, one wonders if they intend to compete against each other to find the best one. Next, they wish to order American jets for delivery in '61, and one can but wonder if they would order a British jet just in case the DC-8 fails! Admittedly B.O.A.C. have stood their ground with the Comet, and credit must be given to them for that, but if they won't play ball with the big jets, then we must do as "Favonius" says and remember that there are other long-haulers in the Empire—Australia, South Africa, India, Pakistan and Canada. Surely there is enough market here to encourage the British industry?

I am forced to the conclusion that your editorial idea that we must leave the big jets to the Americans is solely sour grapes. If we had a big jet coming along the Editor would be the first to cheer. Remember that our industry was large enough to pioneer the turboprop and the 100-seater aircraft, as well as pure-jet transports. We have made mistakes, but we have learnt much and must put this new-found knowledge to work. We can and must rival the DC-8 and Boeing 707. Does any one really believe that the big jet market is half sold out already? The market is growing and there will be many repeat orders. Supersonic travel *may* be just around the corner, but before it comes we shall see the 200-seater subsonic jet built in large numbers. Let us have a share in that market.

London, W.6. AMATEUR.

Identification by Contrails

I CANNOT agree with a number of the statements in the Aircraft Recognition Society's paper on contrails, reproduced in your August 3 number.

Briefly, persistent trails can be formed at all low altitudes down to sea level (I have seen them formed by light training aircraft doing circuits) but they are virtually impossible above 45,000ft or at most 50,000ft. At heights up to about 20,000ft the exhaust plays a negligible part in their formation, which is entirely due to the passage of the aircraft causing condensation in super-saturated air. Such trails start at the aircraft; their shape depends on the wing loading pattern. Frequently they are twin-headed, trailing from the wing tips and occasionally from the airscrews, but the really persistent trail developed from super-saturated air starts as a broad band from every part of the aircraft, except perhaps for dark bands where the heat of the exhaust jets re-evaporates the condensation.

Above 20,000ft the water vapour in the exhaust begins to play a part in forming contrails and above 35,000ft is almost the sole cause of these trails, but there is an important difference between contrails formed by initially supersaturated air and by exhaust vapour. Exhaust formed contrails never start less than about 50ft behind the jet pipes and sometimes the contrail head may be 100 yards or so behind the aircraft.

A turbine engine burning heptane will theoretically produce 1.44 lb of water vapour for every pound of fuel burnt. The air/fuel ratio of the combustion is about 60 : 1 so that the weight of water vapour in the exhaust is about 165 grains per lb of air. This seems a lot of water but the exhaust is very hot, 500-600 deg C, and can only be cooled by mixing with the ambient air. The weight ratio of the ambient/exhaust air mix will have to be about 100 : 1 to bring the mixed temperature to within about 5 deg C of the ambient temperature and this will reduce the excess water to about 1½ gr/lb.

It is quite common, in mixing two masses of air (both initially fairly dry and giving a final mixture which is relatively dry) to cross the saturation line during the mixing process. This is one of the bugbears of cabin conditioning. It is frequently impossible to inject even completely dry cold air into a cabin without a fog area during the mixing process. In considering whether exhaust water vapour can form condensation when mixing with ambient air it is really necessary to go through each step of the mixing process to find if the saturation line is approached or crossed, but some generalizations are permissible, and a broad picture of the possibility or otherwise of contrails can be formed by considering say a standard I.C.A.N. day in which the temperature falls 2 deg C per 1,000ft up to 36,100ft, above which it remains constant at −56.5 deg C. The following table gives the vapour pressure of ice in mm Hg and the grains of water-vapour/lb dry air for the standard day:—

	Height (ft × 1,000)										
	20	25	30	35	36·1	40	45	50	60	70	80
Vap. press. ice (mm Hg) ...	·48	·17	·057	·017	·014	—	—	—	—	—	—
grains/lb ...	6	2·6	1·1	·41	·36	·43	·55	·70	1·13	1·84	2·96

It will be observed that the quantity of water vapour which the air can hold at saturation reaches a minimum of 0.36 gr/lb at 36,100ft and then increases continuously at higher altitudes reaching 3 gr/lb at 80,000ft. In practice it is exceedingly unlikely that the moisture content ever exceeds 0.5 gr/lb in the stratosphere. There is continual exchange of air between the upper and lower regions of the atmosphere and any air in the stratosphere must have passed through a minimum value to get there. In passing through this point the excess water would normally be condensed out into cloud. Now consider the mixing process between exhaust and ambient. At 20,000ft an increase of 5 deg C in temperature would increase the saturation capacity of the air by about 7 gr/lb, but at this point the exhaust mix would only have an excess of about 1½ gr/lb. The saturation curve would be approached only during the mixing process if the air were initially on the point of saturation and the exhaust mixed with 500 to 1,000 times its weight of ambient air, and in this region the excess of water vapour above the saturation level, if any, would be very small and unlikely to form a visible trail. The position is quite different at 30,000 to 35,000ft, where the temperature is much lower and the saturation curve will be crossed at a comparatively low ratio of the ambient/exhaust mix; but at 50,000ft, where the air will be of low relative humidity, the saturation curve will not be crossed except possibly during a very short period of the mixing and any temporary condensation would rapidly re-evaporate and disappear.

It is a well-known law that adiabatic compression of air dries it or reduces the relative humidity and adiabatic expansion increases the relative humidity. An aircraft with a normal wing loading may have negative pressures of ½ lb/sq in over portions of the wing and in the wing-tip vortices. At 10,000ft such a suction would correspond to a temperature drop of 4 deg C and a drop of 6½ from 25.2 to 18.7 gr/lb in the possible water content of the air without super-saturation or condensation. At this height relative humidity of the air is normally fairly high and condensation in the wing-tip vortices would be almost normal except for an aircraft with low wing-loading. Such condensation would re-evaporate very rapidly if the ambient air was below saturation but if any degree of super-saturation existed the persistent type of contrail would be formed.

Andover, Hants. T. P. DE PARAVICINI.

FORTHCOMING EVENTS

Sept. 10-16. Battle of Britain Week.
Sept. 12. Kronfeld Club: Talk on Popular Flying.
Sept. 14-16. International Air Rally, Innsbruck.
Sept. 15. Battle of Britain Day
Sept. 16. All-Britain Model Aircraft Rally, Radlett.
Sept. 17. Aircraft Recognition Society: Lecture by Capt. O. P. Jones, O.B.E., M.V.O.
Sept. 18-23. Aero Club of Italy: International Air Week.
Sept. 19. Kronfeld Club: Film Show.
Sept. 19-21. R.Ae.S. and Institute of Physics: Conference, Cranfield.
Sept. 22-23. Women Pilots' Association: Flying Meeting, Sandown.
Sept. 23. Air Display, Frankfurt.
Sept. 25. Society of Instrument Technology: "Accurate Calibration of Flowmeters," by E. A. Spencer, B.Sc.(Eng.), Ph.D., A.M.I.Mech.E., and A. T. J. Hayward.
Sept. 25-29. 2nd European Aeronautical Congress, Scheveningen.
Sept. 27-28. Aerodrome Owners' Association: Annual Conference, Southampton.
Oct. 1. R.Ae.S.: Main Lecture at Derby: "First Sir Henry Royce Memorial Lecture," by H. I. F. Evernden, M.B.E.
Oct. 4-5. Air Traffic Control Convention, Southend.
Oct. 6. British Interplanetary Society: "Study of the High Atmosphere in the International Geophysical Year," by Prof. H. S. W. Massey, F.R.S.
Oct. 9. R.Ae.S.: Section Lecture: "The Pressure Jet Helicopter," by A. Stepan, Dipl.-Ing.
Oct. 11. R.Ae.S.: Main Lecture at Henlow: "Rocket Motors," by S. Allen, F.R.Ae.S.

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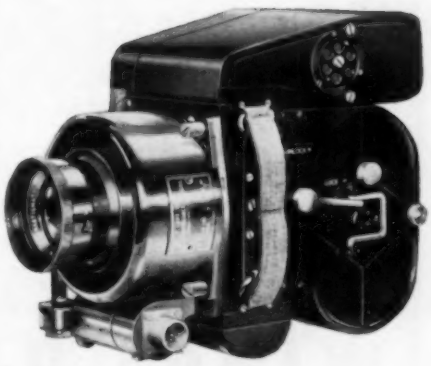

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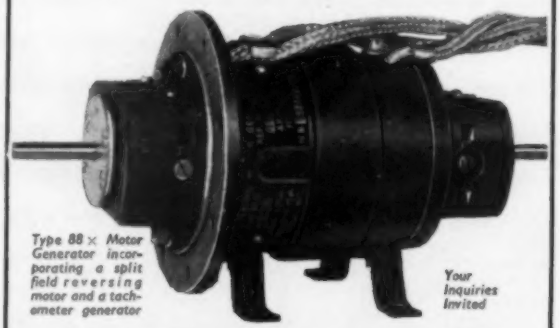

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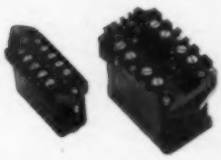

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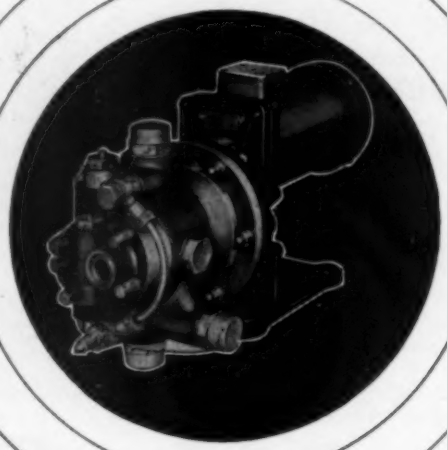

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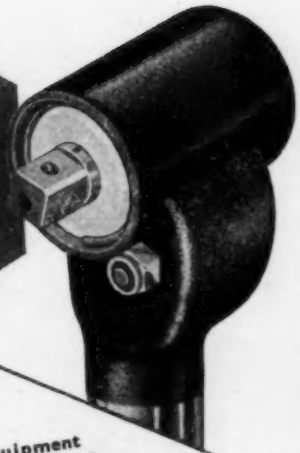

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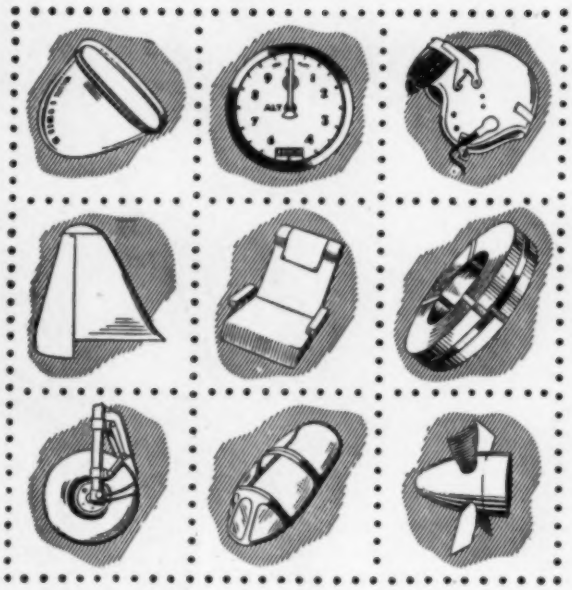

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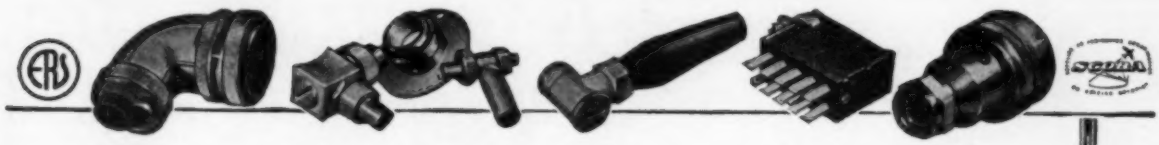

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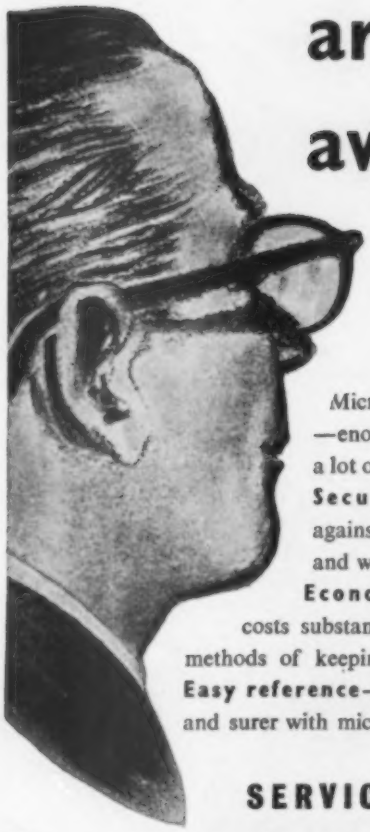

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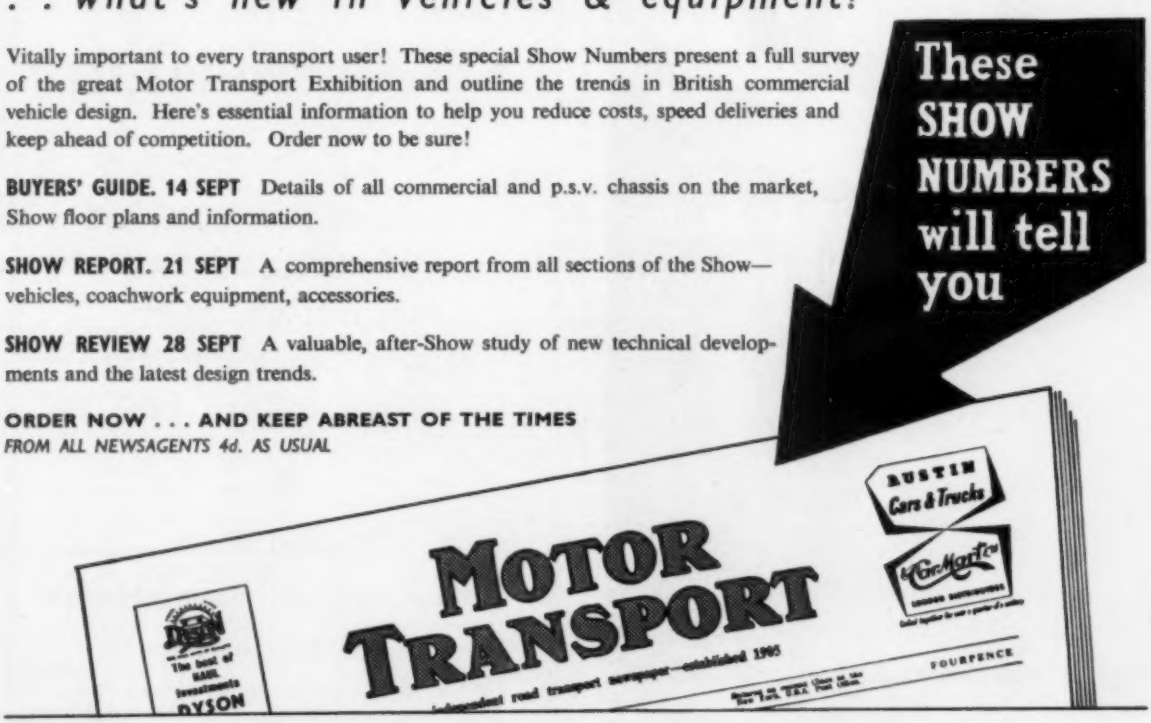

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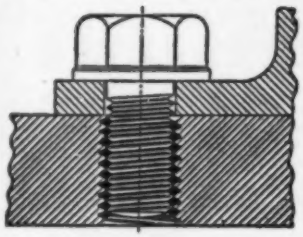

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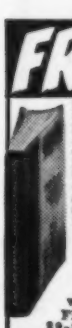

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AIR TRANSPORT ADVISORY COUNCIL

THE Air Transport Advisory Council give notice that they have received the undermentioned applications to operate scheduled air services:—

FROM Eagle Aviation, Ltd., of Marble Arch House, 40 Edgware Road, London, W.2.—Application No. 947. For a Seasonal Normal Scheduled Service with Dakota and Viking aircraft and later possibly with Viscount aircraft for the carriage of passengers, supplementary freight and mail between London (Blackbushe) and Santander and/or San Sebastian (Fuenterabia) at a frequency of up to seven return flights weekly during the season from April to October inclusive each year, for a period of ten years, from date of approval.

APPLICATION No. 948. For a Normal Scheduled Service with Dakota and/or Viking aircraft for the carriage of passengers, supplementary freight and mail between London (Blackbushe) and Ibiza (Escodola) at a frequency of up to seven return flights weekly for a period of ten years, from date of approval.

APPLICATION No. 203/5. From Hunting-Clan Air Transport, Ltd., of London Airport, Hounslow, Middlesex, for permission to include Benghazi (Benina) as an optional traffic stop on the area-to-area All Freight Service between airports in the United Kingdom on the one hand and various authorised traffic points in Malta, the Sudan, East, Central, West and South Africa on the other hand which the Company have been approved to operate for the period up to February 22nd, 1965.

THESE applications will be considered by the Council under the Terms of Reference issued to them by the Minister of Civil Aviation on 30th July, 1952. Any representations or objections with regard to these applications must be made in writing stating the reasons and must reach the Council within 14 days of the date of this advertisement, addressed to the Secretary, Air Transport Advisory Council, 3 Dean's Yard, London, S.W.1, from whom further details of the applications may be obtained. When an objection is made to an application by another air transport company on the grounds that they are applying to operate the route or part of route in question, their application, if not already submitted to the Council, should reach them within the period allowed for the making of representations or objections. [5709

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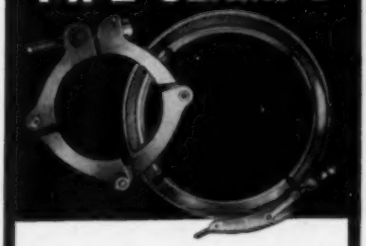
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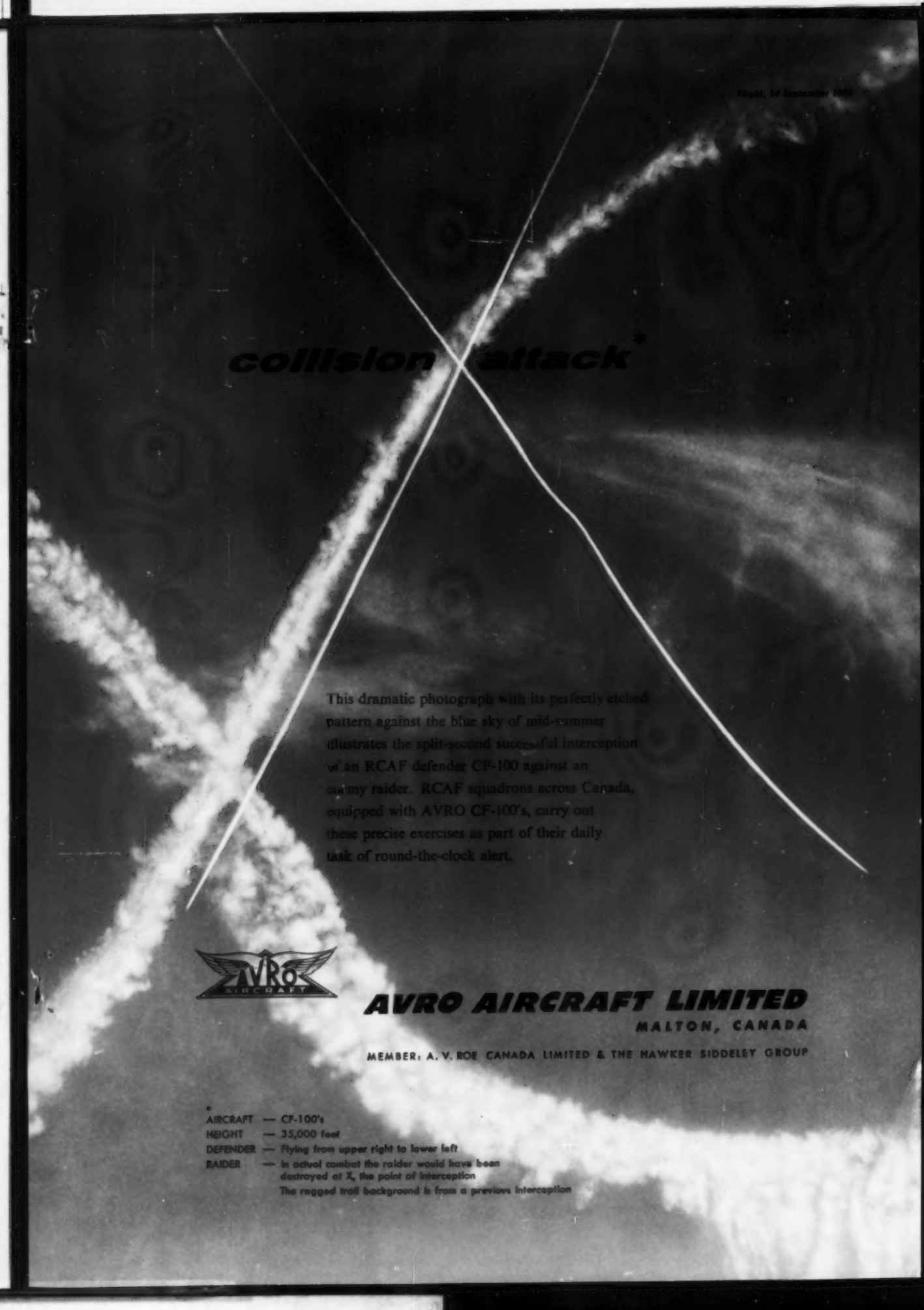

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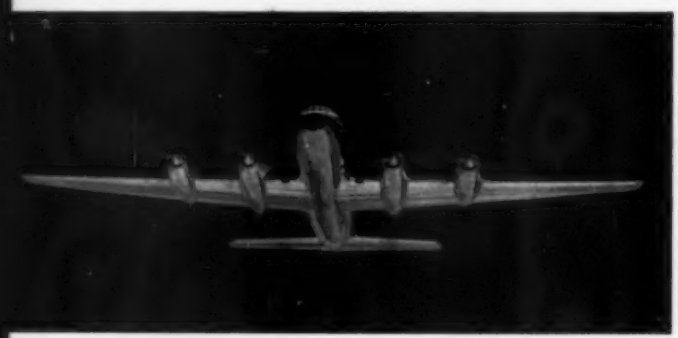

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